Foreign Direct Investment in Renewable Energy in Developing Countries

Alexander Ryota Keeley

博士（総合学術）

Foreign Direct Investment in Renewable Energy in Developing Countries
途上国における再生可能エネルギーへの海外直接投資に関する研究

Alexander Ryota Keeley

京都大学大学院 総合生存学館

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Abstract

One of the 20th century's defining features was the rise of economies that are highly dependent on fossil fuel consumption. In the 21st century, more and more countries are becoming aware of the importance of accelerating the development of renewable energy in order to tackle climate change, air pollution, and to create new economic opportunities as well as to provide sustainable energy for people who are still living without access to electricity. The transformation would not successfully occur unless technologies are transferred properly, and financial resources are allocated in the right way. Thus, this thesis closely examines the flow of foreign direct investment (FDI) in renewable energy in developing countries. FDI serves not just as a great source of capital, but also as an important channel for introducing more productive technology and techniques in a lot of developing countries. The main aims of this thesis are to examine the factors that are determining location decisions of this important financial resource in the emerging sector of renewable energy, and to clarify the required enabling environment to attract FDI in renewable energy sector.

In order to achieve these objectives, the thesis builds on the findings of existing literature and substantiates them by employing holistic analytical approaches; including econometric approaches using SEM analysis, qualitative approaches using AHP analysis, and case studies.

The first finding of this thesis is that renewable energy support policies have equivalent or stronger effects on the location decisions of foreign investors when compared to traditional FDI location determinants such as the macroeconomic environment, institutional environment, and natural resources. This shows that sector-specific determinants are very important factors to consider in order to further our understanding of the determinants of FDI in developing countries. The relative significance among the determinants of FDI in renewable energy in developing countries has also been clarified through both quantitative and qualitative approaches. These findings offer criteria for prioritizing policies and actions that can lead to enhancement of a country's enabling environment for FDI in renewable energy. The analyses have shown that determinants such as exchange rate volatility, access to land, resource availability, feed-in tariff system, and guaranteed access to grid have very strong impacts on the location decisions of foreign investors. Third, building upon these analyses, and through the social implementation of mini-hydro energy projects as well as a field survey in Indonesia, an assessment guideline of the enabling environment for FDI in mini-hydro energy in developing countries is developed, and the results of the assessment of the status of Indonesia are presented.

1. Introduction

Modem industrial development has been largely dependent on fossil fuel consumption, and the inexorable rise of carbon-based economies became one of the 20th century's defining features. Globally, there is growing awareness that increased deployment of renewable energy is critical for addressing climate change, air pollution, creating new economic opportunities, and providing energy access to the billions of people still living without modern energy services. Many developing countries are under pressure to rapidly increase energy generation capacities to address growing demand, to meet energy access challenges, and to foster economic development.[1] Considering the expected growth in electricity demand and increasing emission of greenhouse gas in developing countries, it is imperative to transform the energy system not only of developed countries but that of developing countries.

The transformation will not successfully occur unless technologies are transferred properly, and financial resources are allocated in the right way. This thesis looks closely at the flow of foreign direct investment (FDI) in renewable energy in developing countries in order to examine what are determining location decisions of those important financial resources into the emerging industry of renewable energy, and what are the required conditions to enable FDI projects. The thesis also addressees the research gap observed in studies on determinants of FDI that have actively been conducted by scholars in the discipline of international economics, which is described in detail in the latter section (Section 1.3).

Another important aspect of FDI in developing countries is the impact that FDI brings. How FDI affects development of host countries has been an elusive question, which has been addressed in a lot of studies with mixed opinions. The actual impact that FDI in renewable energy projects brings to developing countries is out of scope of this thesis.[2]

1.1 Renewable Energy in Developing Countries

By approaching renewable energy as part of their industrialization process, developing countries are transitioning from enduring carbon-based economies, dependent on non-renewable sources of electricity such as coal, natural gas and oil to clean-energy economies, and in the process they are generating employment, enhancing energy security, and avoiding burdens on the balance of payments. The main drivers behind renewable energy development in developing

[1] In this thesis, the term "developing countries" indicates countries listed as developing countries on the International Monetary Fund's World Economic Outlook Report (2015)

[2] For a review of theoretical and empirical work on the impact of FDI on developing countries, refer to Moran et al. (2005)

countries can be summarized in the following three inter-related drivers: environmental and sustainable development imperatives, energy security, and the promotion of the renewable energy sector as an emerging strategic industry.

Regarding the first driver, environmental and sustainable development imperatives, developing countries are facing increasing local, national, and international pressure to transform their energy systems to cleaner ones. High-carbon economic activities are causing acute pollution and other environmental problems worldwide, especially in some developing countries. Among developing countries, there are a lot of nations highly vulnerable to the climate change risks of extreme weather and rising sea levels. In addition to local and national pressures to establish cleaner energy systems, many governments in developing countries are under increasing international pressure considering the projected rapid growth of electricity generation in developing countries. This international pressure to transform developing countries' energy systems can also be observed in the historical agreement at COP21, in which incorporating developing countries to the international regime of energy transformation was strongly emphasized.

The second main driver behind renewable energy development in developing countries is energy security, which can be understood in simple conceptual terms as addressing the following aspects described by Dent (2014): supply risk (securing reliable sources of energy fuels), price risk (maintaining predictable or at least stable energy prices), and environmental risk (mitigating the adverse environmental impacts of energy use), as discussed under the first main driver. Among developing countries, with the rapidly growing energy demand, a lot of countries have experienced a rapid depletion of their own fossil fuel deposits, and many of the countries have moved to or are moving toward a net energy-importing position. Renewable energy has the advantage of being inherently indigenous energy sources, which provides a long-term solution to foreign energy supply risk. Also renewable energy technologies have been historically less exposed to price risk than fossil fuel sectors (Dent, 2014).

The third driver behind renewable energy development in developing countries is promotion of the renewable energy sector as an emerging strategic industry. A strategic industry can have any or all of the following general attributes (OECD, 1991): new or emerging sectors with substantial growth potential, which are therefore important for generating future prosperity, income, and welfare; sectors performing essential functions in the economy, such as energy and material supply; and industries providing a material or other kind of foundation on which other sectors are based, such as steel and chemicals for various manufactured products. Most renewable energy sectors such as wind, solar, and hydro energy possess the first general attribute of strategic industry, especially in countries like China and India. Although the core technological foundations of most of the renewable energy technologies can be traced back some decades, considering their rapid growth throughout the world, they may still be considered as an "emerging industry". Renewable energy technologies are also being increasingly deemed in the countries as possessing the second attribute, particularly as a long-term prospect to resolve the aforementioned energy security and environmental predicaments of over-reliance on fossil fuels.

These drivers are facilitating the transition to clean-energy economies, but since the energy demand growth in developing countries is so rapid, fossil fuels still play a significant role in meeting this rising demand, and the forecast shows annual emissions will continue increasing for some time in the developing countries (IEA, 2016). However, in terms of the amount of investment, the center of the renewable energy universe has been shifting from "North" to "South". In 2015, the total investment in renewable energy in developing countries was USD 156 billion, exceeding that in developed countries for the first time in history (REN21, 2016). Developing countries, with growing populations and expanding economies, are in need of a greater amount of investment in their energy sector, and their markets have been perceived as significantly important markets for renewable energy projects by investors. In fact, as of year-end 2016, 92 developing countries set renewable energy targets, and there are some forms of renewable energy support policies (including feed-in tariff, renewable portfolio standard, tradable renewable energy certificate, and tendering) in place in an estimated 68 developing countries (estimated based on: REN21, 2016), demonstrating the growing interests of various governments to attract more investment in the renewable energy sector.

For further facilitation of renewable energy development in developing countries, it "is becoming increasingly a political and financial challenge, not a technical one. Deployment is often constrained by a lack of available financial resources, high costs of capital, or reluctance on the part of investors (REN21, 2015)." Therefore, facilitating the access to finance, and proper allocation of financial resources are one of the keys to promote further development of renewable energy in developing countries.

1.2 Foreign Direct Investment in Renewable Energy Sector

For the development of renewable energy, FDI serves as a great source of capital and an important channel for introducing more productive technology and techniques in a lot of developing countries. Villaverde and Maza (2012) state that one of the most striking developments of the last few decades has been the tremendous growth of FDI in the global economy. Going far beyond simple financing, FDI is instrumental in the rapid and efficient cross-border transfer and adoption of best practice – ranging from technological, managerial, to

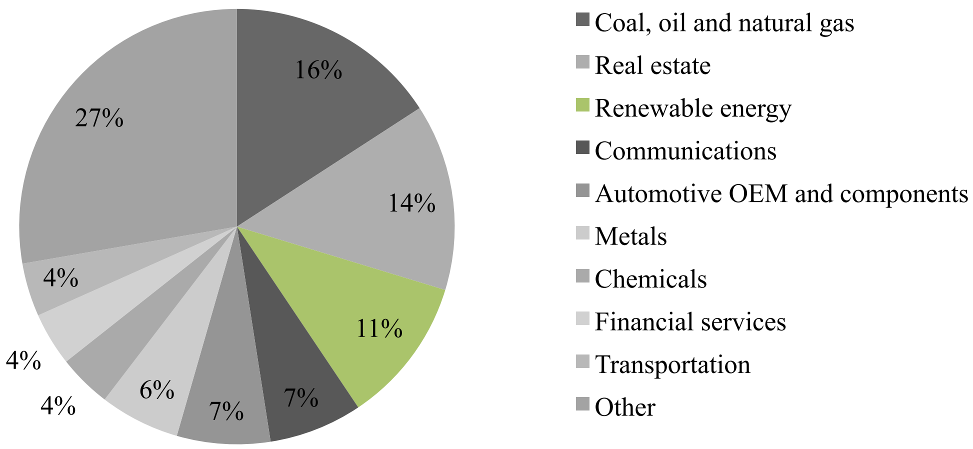


Figure 1.1. FDI (capital investment) by Sector in 2015

Source: based on (fDi Markets, 2016)

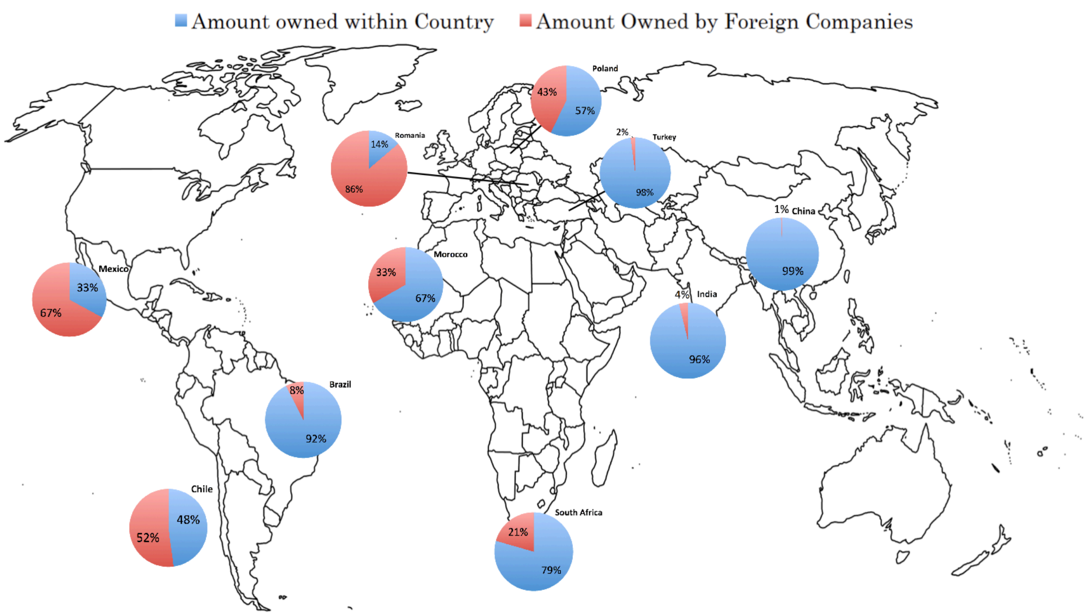


Figure 1.2 Composition of ownership (domestic or foreign) of wind energy plants in top 10 developing countries in terms of the amount of the wind energy installed

Source: GlobalData (2016), created by the author environmental and social standards - which is the essence of economic development (Sun, 2002). As a result, FDI has become a vital component of the economic strategies put forward by most developed and developing countries. In fact, a lot of developing countries are seeking to attract more FDI in renewable energy, which has been increasing steadily worldwide reaching capital investment of USD 76 billion (greenfield FDI), accounting for more than 10% of all greenfield FDI in 2015 as shown in Figure 1.1 (fDi Markets, 2016). However, through analyzing the composition of investment in each developing countries using plant-based data based on GlobalData (2016), it was found that the allocation of FDI differs greatly among developing countries as shown in Figure 1.2 (this is further articulated in Section 3).

One of the keys to mobilizing FDI in renewable energy in developing countries is creating attractive risk/reward profiles, which means higher financial return and lowered risk of investments (Glemarec and Caitlin, 2011). There are various ways that can increase the financial return and minimize the risk of investment both directly and indirectly. This includes i) having renewable support policies such as feed-in tariff, renewable energy certificates and renewable portfolio standards, providing guaranteed access to grid, avoid setting local content requirements, and ii) lowering country-risk and improving business environment. Since there are various factors that could function as determinants that create attractive investment environment for foreign investors, understanding what factors are really significant from investor's perspective provide valuable information for policy makers for creating enabling environment that facilitates FDI in renewable energy, and contributes to analyzing the effect of various renewable energy support policies.

1.3 Methodology and Research Scope

The primary objective of this thesis is to understand what sorts of factors are determining the allocation of FDI in renewable energy in developing countries.

Given the tremendous growth of FDI in the world during the last decades, the analysis of FDI determinants has turned out to be one of the topics attracting more attention in the economic literature. Most empirical studies on FDI have examined this issue from an overall FDI perspective, focusing on classical FDI determinants such as exchange rates, taxes, institutions, trade effects, political risks, etc. A much smaller number of studies, however, have addressed this issue focusing on a specific industry or sector (Mullen & Williams, 2005), for which most of the aforementioned variables could have different effects.

Each industry or sector can be expected to have different types of determinants to attract FDI, thus looking at overall FDI wouldn't provide a clear picture. As it is shown in Figure 1, more than 10% of the total greenfield FDI was allocated into renewable energy sector (FDiIntelligence, 2016), which places it in the top five sectors. Considering the importance of the renewable energy sector specific support instruments such as political support, economic support, and regulatory support for the diffusion of renewable energy from both theoretical and empirical perspectives, these renewable energy sector specific factors could affect the allocation of FDI as much as the traditionally accepted determinants of FDI do.

Hence, investigating the determinants of FDI in renewable energy in developing countries would clarify how important sector specific factors are compared to the traditionally accepted determinants, and would call for the need to investigate determinants of FDI focusing on specific industries or sectors in future studies.

Through the literature review (presented in Chapter 2), another main research gap was identified: John H. Dunning, who is known for proposing the most comprehensive and effective explanation of FDI called eclectic theory, has later on suggested the importance of policy intervention on FDI allocation decisions (Dunning and Lundan, 2006). This sheds light on the importance of the impact of support policies for specific industries on location decisions of FDI, but there is a dearth of empirical evidence that supports this argument. In order to address these main research gaps, the primary research question of the present thesis is:

- Do determinants of FDI in renewable energy sector differ from traditionally argued determinants of FDI?

This first research question brings along series of more specific sub-questions, namely:

- How do renewable energy support policies affect FDI location decisions?
- Do determinants of FDI in the renewable energy sector differ from that of domestic investment?

In order to answer this research question, both quantitative and qualitative approaches are employed: 1) econometric analysis with structural equation modeling; 2) a combination of qualitative and quantitative analysis with semi-structured interviews, questionnaires, and analysis using analytic hierarchy process. As stressed by Painuly (2001), interaction with practitioners in the field through structured interviews and/or questionnaires is very crucial to identify the factors that influence investment decisions. Therefore, in order to reflect the opinions of practitioners and to verify the results of the econometric analysis (approach 1), the approach 2 is conducted.

This first objective of the thesis contributes to the studies on determinants of FDI actively been conducted in the realm of international economics by showing the importance of sector specific factors in comparison to the widely accepted determinants, and highlight the need to investigate determinants of this important international financial resource focusing on a specific industry or sector in future studies. This will also be a contribution to the studies on the effectiveness of renewable energy support policies that are conducted in the field of environmental economics by reexamining their effectiveness from the perspective of FDI.

The secondary objective of this thesis is to develop an analytical guideline building upon the preceding studies and the studies presented in this thesis (Chapter 3 and Chapter 4), and to assess the enabling environment for FDI in one of the renewable energy resources that have high potential in a lot of developing countries, mini-hydro energy. The enabling environment for Indonesia, a country with high potential of mini-hydro energy, will be assessed using the proposed analytical guideline.

The term "enabling environment" refers to a set of interrelated conditions such as legal, technological, fiscal, political, and cultural conditions that have impact on the investors and developers to engage in development processes in a sustained and effective manner. From the perspective of FDI, the location determinants correspond to, or constitute the enabling environment. However, the studies of enabling environment often also deal with more specific barriers using more qualitative approaches. Building upon the studies on the determinants of FDI in renewable energy in developing countries, an analytical guideline of enabling environment for mini-hydro energy will be developed and used to assess the status of Indonesia. This will provide more comprehensive understanding of what kind of conditions are required, or enhance the attractiveness from the perspective of foreign investors.

The concept of the creation of an enabling environment for renewable energy is being increasingly recognized both by scholars and international organizations, shown by the emerging numbers of studies on enabling environments for renewable energy (ex. Abanda, 2012; Markovska et al., 2013). The most notable initiative is the RISE (Regulatory Indicators for Sustainable Energy) project led by the World Bank Group, which developed an analytical guideline of enabling environments for three pillars of sustainable energy—access to modern energy, energy efficiency, and renewable energy. One of the limitations of RISE is that while many factors influence investment (including market conditions, macroeconomic stability, resource endowments, and financial environment), RISE is limited to the policy and regulatory aspects.

Although these examples are great steps toward analyzing the enabling environment for facilitating installation of renewable energy in developing countries, the heterogeneity of investors is not well considered in these studies and initiatives. As expressed by Wustenhagen and Menichetti (2012), considering the heterogeneity of investors, segmentation of investors is critical for understanding necessary environment for attracting investment in renewable energy. For example, as presented in Section 2.2, required enabling environment for renewable energy project could differ among different type of project developers (e.g. international donor agencies, government, and foreign investors). Hence, considering the magnitude and the importance of FDI in developing countries, this thesis contributes to the on-going efforts of the development of analytical guideline of enabling environments for renewable energy by re-capturing the issue standing on the viewpoints of foreign investors (further articulated in Chapter 2). Furthermore, when looking at a certain technology (ex. wind energy or mini-hydro energy), adding to the major factors that will be discussed in answering the first research question, there are minor technology-specific factors that could also affect the enabling environment for investment (ex. administration procedures for obtaining water rights in the case of mini-hydro energy). Therefore, this thesis aims to develop an analytical guideline of enabling environment for FDI in renewable energy focusing on mini-hydro energy, and applies the framework to assess the enabling environment of Indonesia.

This secondary objective of the thesis will be achieved by building upon the results of the analysis of determinants of FDI in wind energy and solar energy (the primary research objective) through the following approach: participant observation in the mini-hydro energy projects in Fukuoka, Japan. The author has been engaged in mini-hydro energy projects in Fukuoka, Japan as an executive project manager, and has been conducting participant observation, which is the process enabling researchers to learn about the subject of the study in the natural setting through observing and participating in the activities. Although the primary focus of this thesis is developing countries, this participant observation in Japan provides a great basis for identifying minor technology-specific factors for developing the analytical guideline of enabling environment for FDI in mini-hydro energy. Then this analytical guideline will be applied to assess the enabling environment of Indonesia, and restructured during the process.

The results of the analyses conducted under the aforementioned two major objectives of the thesis will:

1) Advance the studies on determinants of FDI.
2) Declare the effectiveness of renewable energy support policies.

3) Generate an analytical guideline of enabling environment for FDI in mini-hydro energy.
4) Provide assessment of the current condition of the enabling environment in Indonesia applying the guideline.

These results not only have great academic contribution especially in the field of international economics and environmental economics, but also contribute practically by providing valuable information to facilitate the development of renewable energy in developing countries.

1.4. Outline of the Thesis

The thesis is organized as follows:

Chapter 2 provides a review of theories and empirical studies of determinants of FDI, which will clarify the research gap and also provide basis for selecting variables and forming interviews and questionnaires for the succeeding analyses of determinants of FDI. Chapter 3 presents the results of the econometric analysis of determinants of FDI in wind energy in developing countries using structural equation modeling. Chapter 4 presents the result of the analysis of determinants of FDI in wind energy and solar energy conducted by employing semi-structured interviews and questionnaires, and using analytic hierarchy process as an analysis tool. Chapter 5 first presents the analytical guideline of enabling environment for FDI in mini-hydro energy developed by building upon the results of the analyses presented in Chapter 3 and Chapter 4, and conducting participant observation in mini-hydro energy projects. Then the result of the assessment of the enabling environment in Indonesia using the guideline is shown. Chapter 6 provides the key policy recommendations derived from these analyses presented in this thesis. The final section draws conclusions of the thesis.

2. Theories, Empirical Studies of FDI, and a New Analytical Framework

This chapter first provides a summary of the theories of the determinants of FDI by broadly classifying the theories into macroeconomic approaches, and microeconomic approaches. The first section aims to show the limitation of the theories in explaining the determinants of the FDI. Next, the result of literature review on empirical studies on the determinants and enabling environment for FDI is presented, and the research gaps are identified. Finally, in order to address the observed research gaps, a new analytical framework that is employed in this thesis is proposed.

2.1 Theories of FDI

The growing interest in the causes and consequences of FDI has led to the development of a number of theories aiming to identify the determinants of FDI. The theories can be grouped into two: macroeconomic approaches, and microeconomic approaches.

2.1.1 Macroeconomic approaches

There are two major theories that take macroeconomic approaches. These two theories both assume perfectly competitive markets.

2.1.1.1 Currency-premium theory

One of the first theoretical attempts to explain FDI was based on the Heckscher–Ohlin model of the neoclassical trade theory, in which capital was expected to move to the country with higher capital returns (i.e. the capital-scarce country). Aliber (1970) expanded this view, and further asserted the difference in capital returns was due to a difference in capital endowments and currency risks, since interest rates include a premium that is charged according to the expected currency depreciation. Companies from countries with strong currencies could borrow money at a lower interest rate in their home country due to their lower risk structure in comparison with the companies in the host country with weaker currencies. This means that expected earnings for the foreign companies with access to lower interest rate are higher than companies in the host country, which provides incentive for the foreign companies to conduct FDI. Some scholars such as Buckley and Casson (2016) and Hennart (1982) were doubtful of the view pointing out that many foreign companies raise much of their capital for investment in host countries. However, in the case of FDI in renewable energy, as it was revealed through interactions with practitioners (described in detail in Chapter 4), a lot of foreign companies raise much of their capital in home countries rather than host countries. This fact makes it meaningful to reinvestigate the explanatory power of currency-premium theory for the case of FDI in renewable energy. In fact, a study has shown that renewable energy projects get affected by cost of capital more than traditional energy projects with fossil fuels do (refer to Appendix A for an analysis showing how access to low interest rate impacts renewable energy projects in developing countries). This means that especially for renewable energy projects, developed countries and other countries with access to low interest rate have comparative advantages over domestic companies in host countries, and could be one of the reasons why FDI in renewable energy in developing countries have been rapidly increasing.

2.1.1.2 Dynamic comparative-advantage theory

The dynamic comparative-advantage theory developed by Kojima (2010) is also an extension of the neoclassical theory of factor endowments trade in international production. The theory claims that FDI originates from the comparatively disadvantaged industries of the investing countries, which potentially have comparative advantages in the host country. Kojima's theory attracted widespread attention in the literature, but it was somewhat limited in scope, being criticized that the theory ignores the range of motivations of FDI and lacks applicability to most of the actual FDI (Buckley, 1981).

2.1.2 Microeconomic approaches

In contrast to the aforementioned two theories, there were microeconomic approaches that attempt to develop the theory of FDI under the assumption of imperfect market.

2.1.2.1 Industrial-organization theory

One of the first attempts to develop the theory of FDI under the assumption of imperfect market was made by Hymer (1976), called industrial-organization theory. The main point of the theory is that companies conducting FDI have to compete with domestic companies that have advantages regarding knowledge of culture, language, legal system and customers preference. Foreign companies need to offset these disadvantages to make the investment profitable, and that sources include patented high-quality technology, management skills, brand names, economies of scale and access to low-cost finance. However, Hymer's theory falls in short to provide comprehensive explanation of FDI, especially regarding location choices of FDI.

2.1.2.2 Theory of oligopolistic reaction

Knickerbocker (1973) also developed his theory under the assumption of imperfect market. Some of the major claims on the motives of location choices of FDI are: to increased access to the market of the host country, and to access the relatively abundant factors the host country owns. Knickerbocker added a third motivation of location choice of FDI: in an oligopolistic environment, companies might choose to invest in the country where other rival companies invested in order to maintain their market shares. Knickerbocker argued that companies often show imitative behavior by following the internationalization of rivals so that they will not lose their strategic advantages. He also provided a supportive evidence of the theory by conducting a study using data on the manufacturing FDI of the US companies, finding that oligopolistic companies react to advantages that the company in the similar industry may gain from its FDI through following it with their own FDI so that the to maintain a competitive equilibrium.

2.1.2.3 Risk-diversification theory

Rugman (1975) asserted that companies conduct FDI in order to diversify product and market and reduce variance in their profits. Operating abroad was perceived as a diversification from solely relying on domestic market. Some supportive evidence were provided by studies conducted by scholars such as Hughes et al. (1975), which showed that multinational corporations had higher average returns and lower systematic and unsystematic risk in comparison with domestic firms. Although, this theory explains the motivations of FDI, it does not provide explanation on why certain countries are chosen as the destinations of FDI.

2.1.2.4 The eclectic theory

Among all the endeavors to develop a theoretical framework that explains FDI, eclectic theory developed by Dunning (1980) is known as the most comprehensive and effective explanation of FDI. The eclectic theory is a mix of different theories of FDI, which is referred to as OLI paradigm: "O" from Ownership advantages, "L" from Location advantages, and "I" from Internalization advantages. Dunning pointed out that foreign companies must posses certain advantages in comparison with domestic companies since they face cultural, language, and administrative procedure differences, and other factors that drive the setting up and operating cost up in addition to those faced by the domestic companies. In the OLI paradigm, location advantages are the key factors that determine which country will become the host country for the FDI. The location advantages of each country include the followings: qualitative and quantitative factors of production, transportation cost, infrastructure, market size, distance between the home and host countries, cultural diversity, and attitude towards outsiders etc.

Although the eclectic theory points out some of the potential determinants of FDI, and it is a strong framework of analysis that deliberately draws on a variety of theoretical approaches, on the other side of the coin, the eclectic theory is weak when ascertaining which factors are the most decisive in attracting FDI. Some scholars assert that the eclectic theory "is not a theory but a paradigm" (Cantwell, 1988) or "taxonomy of various determinants of FDI" (Itaki, 1991).

Later on Dunning and Lundan (2006) further worked on the research of the determinants of FDI in terms of locational advantages of OLI paradigm, reflecting the growing impact of location choice of FDI to the host economies. According to their research, three types of factors that influence the location choice of FDI have been identified: "endowment effects", which refer to the existence of low-cost labour force or natural resources; "agglomeration effects", which is indicating that the 'the attraction of one firm will generally make it more attractive for another firm to co-locate in the same region' (Dunning and Lundan 2006); and lastly, "policy-induced effects", which indicate the impacts of common and specific government policies on location decision of FDI. This work by Dunning and Lundan shed light on the importance of the impact of support policies for specific sectors on location decisions of FDI. However, as it is reviewed in the following section, this aspect lacks supporting empirical evidences especially for sector-specific support policies.

2.2 Empirical Studies on Determinants and Enabling Environment of FDI

2.2.1 Empirical studies on determinants of FDI

As reviewed in the preceding section, the absence of a widely accepted theoretical framework that explains FDI has led researchers to rely on empirical evidence for understanding the determinants of FDI. This section presents the result of the literature review on determinants of FDI. The determinants empirically tested in the preceding studies can predominantly be categorized in institutional environment, macroeconomic environment, and policy intervention. Here, policy intervention is defined as factors that have high controllability by the government. The preceding studies introduced below are summarized in Table 2.1, and it shows that most of the studies mainly consider institutional environment and macroeconomic environment as determinants of FDI, but much less studies investigate the effect of policy intervention, especially regarding sector-specific support policies.

Büsse and Hefeker (2007) analyze the effect of political risk and institutions on FDI inflows to developing countries, with a data sample of 83 developing countries during the period from 1984 to 2003. Using a combination of econometric techniques, a country fixed-effects model and the Arellano–Bond Generalized Method of Moments (GMM) estimator, they find that

Table 2.1 List of reviewed factors

Category	Factor	Reference
Institutional environment	Political risk	Büsse and Hefeker, 2007; Edwards, 1990; Kim, 2010; Merlevede and Schoors
	Rule of law (effective law enforcement)	Anyanwu, 2012; Jadhav, 2012; Kinoshita and Campos, 2002; Merlevede and Schoors
	Efficient and transparent administrative procedure	Dollar et al., 2001; Dumludag, 2009; Morisset and Lumenga-Neso, 2002; Pîrlogea, 2011
	Corruption	Mateev, 2009; Painuly, 2001; Pîrlogea, 2011; UNEP, 2012
Macroeconomic environment	Access to local finance	Alfaro et al., 2008; Merlevede and Schoors, 2005; Painuly, 2001; Zeng et al., 2017
	Exchange rate stability	Barrel and Pain, 1998; Cushman, 1988; Globerman and Shapiro, 2003; Urata and Kiyota, 2004
	Labor cost	Charkrabarti, 2001; Culem,1988; Mateev, 2009; ODI, 1997; Shamsuddin, 1994; Urata and Kiyota, 2004
	Geographical proximity	Kinoshita and Campos, 2002; Mateev, 2009
	Market size	Anuchitworawong and Thampanishvong, 2015; Blanc-Brude et al., 2014; Charkrabarti, 2001; Cooray et al., 2014; Edwards, 1990; Mateev, 2009
	Infrastructure	Blanc-Brude et al., 2014; Chan et al., 2014; Demirhan and Masca, 2008; ODI, 1997; Painuly. 2001
Policy Intervention	Tax rate (corporate)	Demirhan and Masca, 2008; Grubert and Mutti, 1991; Kemsley, 1998; Tang et al., 2014; Root and Ahmed, 1978
	Tax holiday	Black and Hoyt, 1989; Loree and Guinsinger, 1995; Rolfe et al.,1993
	Tariff rate	Grubert and Mutti, 1991
	Performance requirement	Loree and Guinsinger, 1995

stability and democratic accountability of government, corruption, law and order, ethnic tensions, and quality of bureaucracy are strong determinants o FDI.

Edwards (1990) presents the results of an econometric analysis of the determinants of the cross-country distribution of the FDI into developing countries. The analysis provides evidence in terms of both economic and political variables, including GDP and political risk. The variables political instability and political violence are statistically significant determinants of location decisions of FDI into developing countries.

While macroeconomic determinants are considered as strong determinants of FDI in general, there are scholars such as Lucas (1990) who argue that only political factors limit FDI inflows. Alfaro et al. (2008) provide empirical support for this argument by conducting econometric analyses using the ordinary least squares estimates. They investigate the role of a different set of determinants, especially focusing on institutional quality and show that improving the quality of institutions of developing countries, which is measured by factors such as government stability, internal and external conflict, corruption, law and order, and bureaucratic quality, leads to increases in FDI. The study conducted by Merlevede and Schoors (2005) investigates the determinants of FDI in European developing countries, and they also find institutional quality to be a robust determinant of FDI.

Using the standard GMM with panel data of 25 developing countries between 1990 and 1998, Kinoshita and Campos (2003) find that agglomeration effects are strong for FDI in the examined countries, and the quality of the bureaucracy and rule of law are statistically significant determinants. Urata and Kiyota (2004) investigate the effect of exchange rate volatility on FDI from developed economies, and find that high volatility of the exchange rate discourages FDI inflows. The study also finds low wages and trade openness as statistically significant determinants, and confirms the importance of the agglomeration effect.

Anyanwu (2012) conducts cross-country regressions analysis focusing on African countries for the period 1996-2008, and also finds positive relationships between rule of law and FDI inflows. Market size, openness to trade, and natural resource endowment were also found to be strong determinants of FDI. The analysis also finds that there are negative relationships between higher financial development and FDI inflows, which suggests that FDI is a substitute for financial market development in African countries. Asiedu (2002) has examined the determinants of FDI focusing on 22 African countries using fixed-effects panel estimation with panel data spanning over the period 1984–2000. The study shows that market size, natural resource endowments, infrastructure, and stable and low inflation rate attract FDI.

A study focusing on the impact of economic, institutional and political factors on location decisions of FDI in Brazil, Russia, India and China shows that market size (real GDP) is a strong determinant of FDI, together with trade openness, and rule of law (Jadhav, 2012). Findings by Jadhav also show that macroeconomic factors are more important than institutional factors.

Mateev (2009) analyzes the determinants of FDI flows in Southeastern and Central European countries, and shows that gravity factors (distance, population, and GDP) and other factors such as labor costs, and corruption are strong determinants of FDI.

Chakrabarti (2001) uses extreme bound analysis with a sample of 135 countries for the year 1994 to investigate if the determinants tested in other preceding studies are robust to small changes in the conditioning information set. The study shows that market size, as measured by per-capita GDP is a strong and robust determinant of FDI, while the study also found that many of the determinants that have been presented in the preceding empirical studies (such as wage rate, tax rate, trade openness, and exchange rate) are very sensitive to small change in the conditioning information set.

One of the first empirical studies to analyze the effect of policy intervention in detail is by Root and Ahmed (1978) who tested 44 economic, social, and political and policy variables for significance using data on FDI inflows of 41 developing countries. Classifying the countries in three categories (unattractive, moderately attractive and highly attractive) according to their annual per capita FDI inflow, they found that – apart from per capita GDP, export–import ratio and commerce, transport and communication ratio and extent of urbanization – the corporate tax level discouraged and regular executive transfers encouraged FDI, while tax incentives laws and liberality were not significant.

Grubert and Mutti (1991) undertook a cross-sectional study of the US FDI stock in 33 countries and found the stock of plant and equipment and the US exports to affiliates and to countries in general to be increasing in the inverse of the tax rate (i.e. reducing the host country's tax rate had a positive effect), and the tariff rate.

Rolfe et al. (1993) asked managers of almost 900 US firms with operations in the Caribbean region to assess the attractiveness of 20 host country incentives. Overall, no restrictions on intercompany payments, no controls on dividend remittances, import duty concessions, guarantees against expropriation and tax holidays proved to be the most important incentives.

Loree and Guisinger (1995) examined the effects of policy and non-policy variables on the location of US FDI outflows using data on 48 countries. Investment incentives increased FDI flows, while performance requirements and host country effective tax rates decreased FDI flows

Black and Hoyt (1989) analyzed the competition between two cities when bidding for firms. In their model, firms located in the city with the best combination of wages, costs and tax holidays.

There are also case studies that show the important effects policy interventions have on the decision-makings of FDI. Larraín et al. (2000) investigated the determinants of FDI by focusing on the FDI conducted by Intel, a manufacturer of microprocessors, in Central America. While the study provided supportive argument that institutional and macroeconomic factors such as political stability, labor quality, corruption level, and legal system worked as determinants of Intel's FDI to Costa Rica, the thorough study of the case showed that a well-coordinated effort that involved ministries, independent agencies, and institutions of higher education also played a great role in attracting Intel's investment. The study also highlighted the fiscal benefits provided under the Costa Rican free-zone regime for foreign companies was also a key determinant in Intel's decision making.

This literature review of empirical studies on determinants of FDI reveals two research gaps in the field. First, most of the empirical studies on the determinants of FDI have examined the determinants of FDI focusing on overall FDI, with much a smaller number of studies addressing this issue focusing on a specific industry or sector. Some of the sector-level analyses such as the ones in banking sector (Moshirian, 2001), advertising sector (Terpstra and Yu, 1988), and legal service sector (CulleneMandikos and MacPherson, 2002) clearly show that determinants of FDI could differ among different sectors.

Second, despite of the suggested importance of policy interventions as determinants of FDI by Dunning and Lundan (2008), most of the studies consider institutional environment and macroeconomic environment as determinants of FDI. The studies that test the impact of policy interventions such as corporate tax rates, tax concessions, tariffs and other fiscal and financial investment incentives show that policy interventions had significant effects on FDI, and should thus be considered as potentially important determinants of FDI.

2.2.2 Empirical studies on enabling environment

As introduced in Introduction, enabling environment refers to a set of interrelated factors that have impact on the investors and developers to engage in development processes in a sustained and effective manner. From the standpoint of FDI, the location determinants correspond to, or constitute the enabling environment. However, the studies of enabling environment often also deal with more specific barriers using more qualitative approaches.

Sun (2002) asserts that enabling environment for FDI has several components, political and macroeconomic stabilities being absolute pre-requisite factors. The study elucidates that a body of clear laws and regulations and the efficient administrative bodies are needed, and rampant inflation should be resolved to enhance the enabling environment for FDI.

Rajan (2004) looks into the enabling environment required to attract FDI, and suggests potential policy interventions. The study states that dismantling barriers to the free entry and exit of foreign investors, relieving some infrastructural bottlenecks (roads, ports and storage), reducing other transactions costs of doing business (e.g. investment approvals, custom clearance), and strengthening overall governance (including strengthening intellectual property rights) are crucial factors that constitute the enabling environment for FDI.

Referring to the study of OECD (2002) on measures to maximizing benefits and minimizing cost of FDI for developing countries, Mar (2015) focuses on analyzing Myanmar's enabling environment for FDI, and argues the need to improve macroeconomic stability, the quality of financial intermediation, business environment, and relevant infrastructure.

These studies shed light on the important conditions for attracting FDI in general, and potential measures that could be taken by host countries. However, the actual enabling environment is far more complex when dealing with FDI in certain sectors or technologies.

Recently, creating an enabling environment for renewable energy has increasingly been a topic of discussion among scholars, international organizations, and policy makers. Souvik and Sourav (2017) investigate opportunities, barriers and issues with renewable energy development, and analyze required enabling environment. They point out that technology-specific deployment targets backed by dedicated policies that are tailored to each country's local conditions as well as to the market segment is an important enabling environment to provide both policy guidance and long-term planning security for the public and private sectors. Also, clarity of institutional roles that are related to project evaluation, permitting and licensing accompanied by transparent and streamlined procedures is raised as another important environment. Finally, they conclude that education and awareness raising at public and institutional level is an important part of creating an enabling environment for renewable energy.

Keeley (2017) investigates the required enabling environment for implementing renewable energy projects in Small Island Developing States from the perspective of international aid. The author elucidates that detailed and well-structured action plan, and financial transparency and sustainability of utility company are some of the important factors that constitute the enabling environment. The author also stresses that technological capacity of a host country is less important from the perspective of international aid since to some extent well-qualified development partners can handle it in international aid projects.

Barnsley et al. (2015) analyze the required enabling environment for renewable energy projects in general, and assess the status of the enabling environment mainly focusing on Eastern Europe, Caucasus, Central Asia, Southern and Eastern Mediterranean countries. They classify the factors that constitute the enabling environment in to technical factors, infrastructure and innovation factors, financial and market factors, social factors, regulatory and institutional factors, and environmental factors. They especially point out that resolving difficulties in gaining the necessary permits, skills shortages, and inflexibility of energy system to absorb electricity generated with renewable energy sources would enhance a country's enabling environment for renewable energy projects.

Drawing on the works by IEA-RETD, Koch (2012) states that stability, predictability, and clarity for stakeholders are the keys for facilitating renewable energy development. The study argues that renewable energy support policies must be part of a broader package of parallel policies such as spatial planning, and building codes. The study also points out that priority should be placed on transparency and ease of administration, clear and simple permitting procedures, low-interest loans, and revolving public funds for enhancing a country's enabling environment.

Although these studies on enabling environment for renewable energy development are great steps toward understanding the required enabling environment, considering the heterogeneity of investors as expressed by Wustenhagen and Menichetti (2012), more segmentation of project developers (e.g. international donor agencies, government, and foreign investors) is critical for understanding necessary environment for attracting investments in renewable energy. Hence, this thesis will address this point by investigating enabling environment of renewable energy development in developing countries focusing on the perspective of FDI, and contributes to the on-going efforts of the development of analytical guideline of enabling environments for renewable energy development.

2.3 A New Analytical Framework of determinants of FDI

In section 2.1, we saw that the proposed theoretical framework falls in short to provide comprehensive explanation of location choices of FDI. The absence of a widely accepted theoretical framework that explains FDI has led researchers to rely on empirical evidence for understanding the determinants of FDI.

As reviewed in the preceding section, regardless of the underlying hypothesis, different combinations of various variables have been considered in the preceding studies and they have provided mixed results both in terms of the statistical significance and the direction of causality relationship. Moosa states that consensus can hardly be reached on explanatory variables that could be perceived as “true” determinants of FDI due to the mixed results of the preceding studies (Moosa. 2009). As suggested in the last section, the primary reason why the preceding studies are producing inconsistent result is because of the use of overall FDI (aggregated FDI) data instead of sector-level FDI data. As shown in Figure 1, including the 11% share of renewable energy sector, the top five sectors constitute more than 50% of the green-field FDI in 2015. Considering that determinants of FDI could differ among different sectors, the focus of analyses need to shift to sector-level, which will bring much clearer resolution of the issue.

Another important point of shifting the focus of analyses to sector-level is to look into the impact of policy interventions as determinants of FDI as asserted in the preceding section. Preceding studies that looked into the effect of policy interventions are only able to provide empirical supports for factors such as corporate tax rates, tax concessions, tariffs and other fiscal and financial investment incentives, while there are various sector-specific policy interventions that could work as strong determinants of FDI.

Adding to this, in order to provide answers of “true” determinants of FDI, the analyses of the determinants of FDI should be conducted combining macro and micro approaches, bridging econometric studies and case studies. Compared to the booming numbers of the studies of the determinants of FDI using econometric approaches, case studies that look into the determinants of FDI are scarce. While the accumulation of sector-level data allows us to conduct econometric analyses with higher resolution, there are still numbers of factors that are not or can hardly be quantified, and there could be various country-specific barriers that hinder FDI. As stated by George and Andrew (2005), case studies “can look at a large number of intervening variables and inductively observe any unexpected aspects of the operation of a particular causal mechanism or help identify what conditions present in a case activate the causal mechanism". Thus, combining econometric studies and case studies could greatly enhance our understanding of the issue with much clearer resolution.

Having these points in mind, a new analytical framework of the determinants of FDI is proposed in this thesis (Figure 2.1). The new analytical framework of the determinants of FDI takes the following steps: 1) econometric analysis focusing on a specific sector, 2) interactions with practitioners in the field, and 3) case studies focusing on specific country and investment target. The step 2) could preferably be conducted through interviews and questionnaires, collecting both qualitative and quantitative data to compensate the findings observed through the econometric analysis. The step 3) works both as a way to validate the findings observed through the first two steps, and a way to identify more detailed factors and unexpected factors that constitute enabling environment for FDI and affect decision makings of foreign investors.

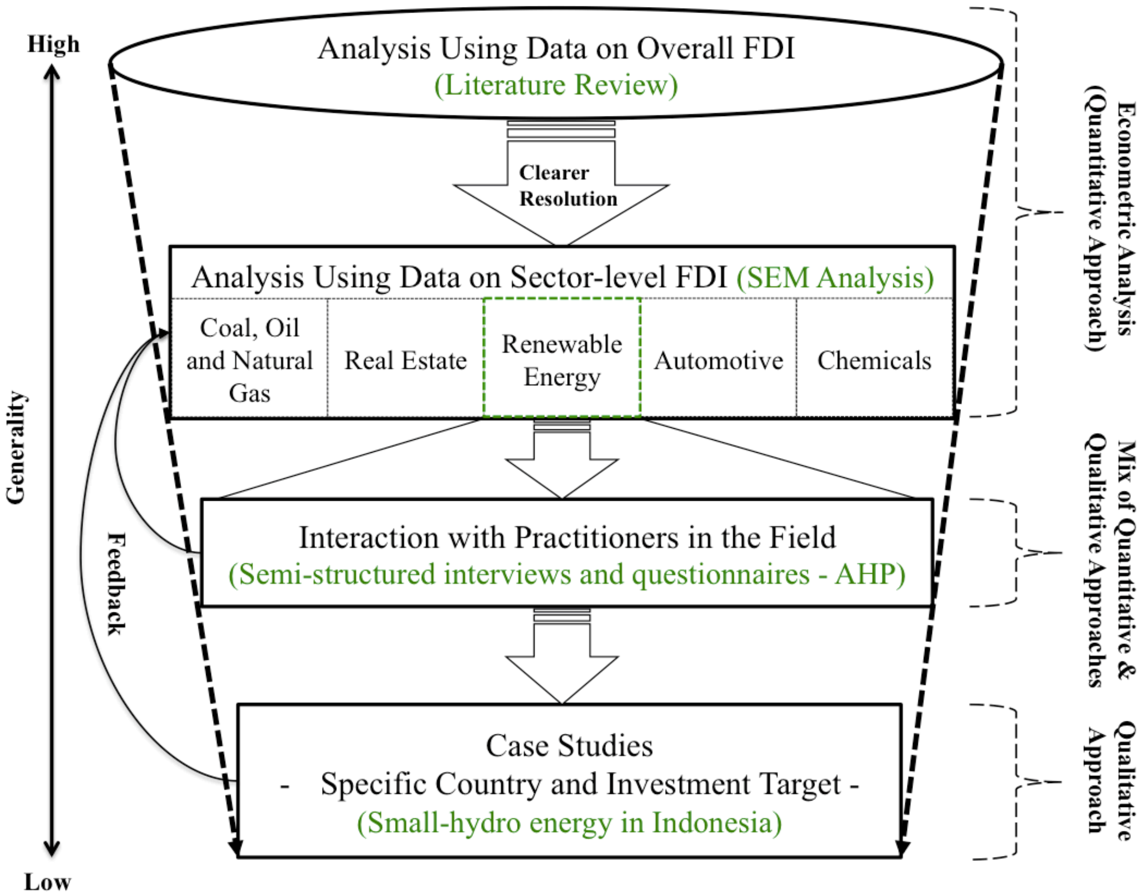


Figure 2.1 An Analytical framework of determinants of FDI (texts in green represent steps followed in this thesis)

*Created by the author

This new analytical framework enables us to advance our understanding of the determinants of FDI with much clearer resolution. In this thesis, based on this analytical framework, the analyses of the determinants of FDI are conducted focusing on renewable energy sector in developing countries.

3. The Effectiveness of RE Policies in attracting FDI – Econometric Approach

Given the tremendous growth of FDI in the world during the last decades, the analysis of FDI determinants has turned out to be one of the topics attracting more attention in the economic literature. As reviewed in Chapter 2, most empirical studies on FDI have examined this issue from an overall FDI perspective, focusing on classical FDI determinants such as exchange rates, taxes, institutions, trade effects, political risks, etc. As shown in Figure 1.1, more than 11% (USD 76 billion) of the total greenfield FDI in 2015 was allocated to the renewable energy sector. The renewable energy sector is one of the fastest growing sectors attracting great amount of FDI, being one of the top 5 sectors in terms of the amount of FDI allocated. Considering the importance of this sector, it is valuable to look at how the determinants in this sector are different from the traditional determinants. Furthermore, this emerging sector has been supported by various economic, regulatory, and political policies. For example, the effect of feed-in tariff policy on the development of renewable energy has been well discussed among environmental economists (Abdmouleh et al., 2015; Eyraud, et al., 2013; Jacobsson and Lauber, 2006). Considering the importance of these economic, regulatory, and political policies, it is reasonable to assume that the existence of these instruments affects the decision making of foreign investors more than the traditionally argued determinants of FDI do. Therefore, this chapter aims to clarify the determinants of FDI in renewable energy sector, focusing on wind energy in developing countries, and also empirically examine the impact of these renewable energy support policies using econometric approaches.

3.1 Explanatory Variables of the FDI in Wind Energy in Developing Countries

The analysis examines a large number of variables that have been set forth to explain FDI in renewable energy in developing countries. Some of these variables are included in preceding studies or theories of FDI, and some are taken from preceding studies on renewable energy diffusion.

As summarized in the Table 3.1, GDP growth, FDI, monetary freedom, trade freedom, investment freedom, financial freedom, labor freedom, control of corruption, government effectiveness, regulatory quality, rule of law, political stability, renewable energy (RE) policy support, RE regulatory support, and RE economic support are selected as variables that will be taken into the analysis. The indices monetary freedom, trade freedom, investment freedom, financial freedom, and labor freedom are from the heritage foundation. The indices GDP growth, FDI, control of corruption, government effectiveness, regulatory quality, rule of law, and political stability are from world development indicators. RE policy support, RE regulatory support, and RE economic support take dummy variable of value 1 from the first year of implementation of political, regulatory, and economic support policies for the promotion of RE onward, which are created based on the database of IEA/IRENA and global status report of REN21 (REN 21, 2009, 2010, 2011, 2012, 2014, 2015).

Table 3.1 Definitions of variables and their sources.

Variable	Definition	Data Source
GDP growth	Growth of annual GDP	WDI
FDI	FDI net inflows as a percentage of GDP	WDI
Monetary Freedom (MF)	Price stability with an assessment of price controls	The Heritage Foundation
Trade Freedom (TF)	Absence of tariff and non-tariff barriers	The Heritage Foundation
Investment Freedom (IF)	Investment restrictions on foreign investors	The Heritage Foundation
Financial Freedom (FF)	Extent of financial and capital market development etc.	The Heritage Foundation
Labor Freedom (LF)	Regulations concerning minimum wages, laws inhibiting layoffs, and severance requirements etc.	The Heritage Foundation
Control of Corruption (CC)	Extent to which public power is exercised for private gain	WDI
Government Effectiveness (GE)	Quality of policy formulation and implementation, and the government's commitment to such policies	WDI
Regulatory Quality (RQ)	Ability of the government to formulate and implement sound policies and regulations	WDI
Rule of Law (RoL)	Extent to which agents have confidence in and abide by the rules of society	WDI
Political Stability (PS)	Measurement of the likelihood of political instability	WDI
RE Economic	Dummy variable taking value 1 from the first year of implementation of economic support for the promotion of RE onward	IEA/IRENA, REN21
RE Policy	Dummy variable taking value 1 from the first year of implementation of policy support for the promotion of RE onward	IEA/IRENA, REN21
RE Regulatory	Dummy variable taking value 1 from the first year of implementation of regulatory support for the promotion of RE onward	IEA/IRENA, REN21

3.2 Data Source and Methods

In this section, the data source employed in the analysis and the analysis methods are explained.

3.2.1 Data Source

Data of existing installed wind plants was taken from GlobalData (2016). Data includes location, owner, installed year, and capacity of the plants. Based on the ownership data, plants that are owned by companies who have their headquarters in countries (home country) different from the country where the plant is installed (host country) are counted as foreign direct investment in wind energy plants. In case more than one company owns a plant, the capacity of the plant is simply divided by the number of owners for the convenience sake.

Capacity and the number of the FDI projects are used as a proxy for the amount of FDI in wind energy in developing countries. Based on the collected data, most of the wind energy plants were installed after 2008 as shown in the Figure 3.1. Therefore, data on wind energy plants installed between 2008 and 2014 was used in the analysis. Between 2008 and 2014, a total of 190 foreign direct investment projects were conducted, which accounted for 7950 MW of wind plants in developing countries. Taking the installed capacity and the number of projects as the dependent variables, an exploratory factor analysis (EFA) followed by structured equation modeling (SEM) was used to model structured relationships between the variables. Also, the same analysis was conducted for wind energy plants owned by domestic companies in order to further clarify the drivers of FDI in wind energy in developing countries by comparing the outcome of domestic investment and foreign direct investment. Similar to FDI, based on the ownership data, plants that are owned by domestic companies are counted as domestic investment. Some of the plant data lacked information on the ownership of the plant, which are also counted as domestic investment in this analysis. Between the year 2008 to 2014, a total of 2626 projects were conducted, which accounted for 52790 MW of wind plants in developing countries.

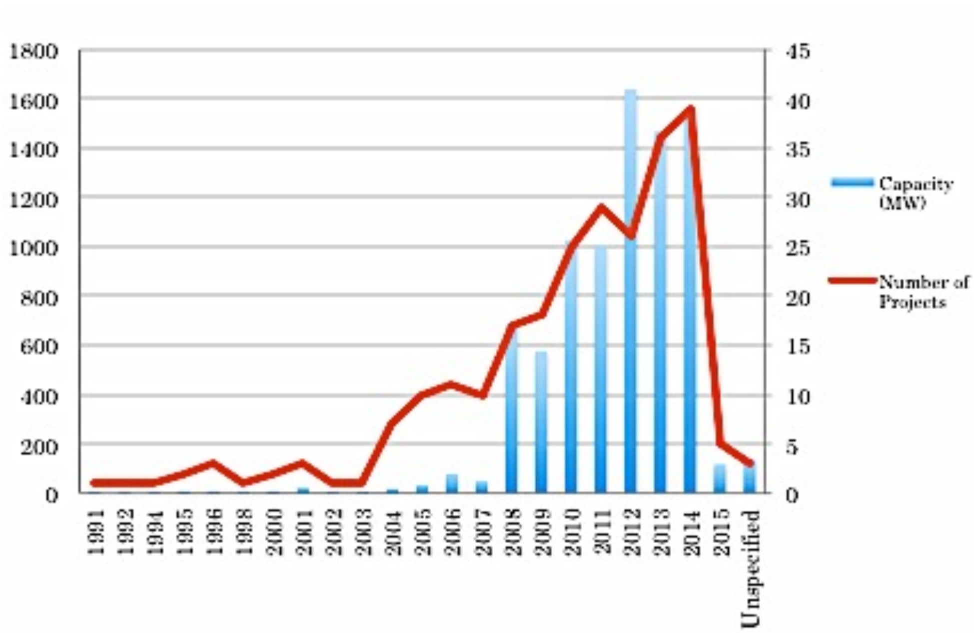


Figure 3.1 FDI in wind energy in developing countries, capacity and number of projects by year. Source: GlobalData (2016)

Table 3.2 Composition of ownership of wind energy plants in top 10 developing countries in terms of the amount of the wind energy plants installed Source: GlobalData (2016), created by the author *the numbers are all in MW

Country	Amount owned within Country	Amount Owned by Foreign Companies	Unspecified	Total Capacity (MW)
China	32,512	273	13,064	45,849
India	15,917	662	698	17,278
Brazil	5,751	472	59	6,283
Turkey	3,172	15	39	3,225
Poland	1,428	1,308	320	3,056
Romania	141	2,138	199	2,478
Mexico	768	1,565	0	2,333
Chile	326	371	14	711
South Africa	498	129	0	627
Morocco	352	201	51	604

Table 3.3 Composition of ownership of solar energy plants in top 10 developing countries in terms of the amount of the solar energy plants installed Source: GlobalData (2016), created by the author *the numbers are all in MW

Country	Amount of Capacity owned within Country	Amount of Capacity owned by Foreign Companies	Unspecified	Total Capacity (MW)
China	12830.824	34	6610.812	19475.636
India	3092.852	300	651.121	4043.973
South Africa	527.7226667	1018.083333	5.886	1551.692
Thailand	1094.0225	53.3845	193.452	1340.859
Romania	193.36	608.265	490.14	1291.765
Bulgaria	84.1	462.65	365.557	912.307
Ukraine	523.85	0	94.861	618.711
Chile	67.73333333	452.8266667	40.33	560.89
Israel	152.356	48.5	48.73	249.586
Malaysia	71.021	15	71.712	157.733

In terms of the composition of ownership of wind energy plants in developing countries, the data collected from GlobalData (2016) revealed that the percentage of FDI in the total amount invested greatly varies among countries as shown in Table 6.2. For example in China, the leading country in terms of the amount of wind energy plants installed, only 273 MW of wind energy plants are owned by foreign companies, which accounts for merely 1% of the total amount installed. On the other hand, in Mexico more than 1500 MW of wind energy plants are owned by foreign companies, which is more than double of the amount owned by domestic companies.

Similar outcomes can be seen in the solar energy plants in developing countries, too. As summarized in Table 3.3, the percentage of solar energy plants owned by foreign companies greatly varies among countries. These data also strongly support the importance of the analysis of the determinants of FDI in renewable energy in developing countries.

3.2.2 Methods: exploratory factor analysis and structured equation modeling

The effect of each variable on the amount of FDI in wind energy in developing countries, and the relation between the variables will be analyzed with using exploratory factor analysis and structured equation modeling.

3.2.2.1 Explanatory factor analysis

As a result of the technological advancements of computers, factor analysis has been employed in many fields, including social and behavioral sciences, geography, economics. Confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) are the two main factor analysis techniques. The aim of CFA is to examine the explanatory power of hypotheses, while EFA aims to simplify complex patterns by testing predictions (Child, 2006).

The primary assumption of factor analysis is that a smaller number of underlying latent factors can explain the covariance between a set of observed variables. In EFA, it proceeds as if there were no hypotheses regarding the relationship of the latent factors and the observed variables, and the number of latent factors. The final goal of factor analysis is to reduce "the dimensionality of the original space and to give an interpretation to the new space, spanned by a reduced number of new dimensions which are supposed to underlie the old ones" (Rietveld and Van Hout 1993). Therefore, "factor analysis offers not only the possibility of gaining a clear view of the data, but also the possibility of using the output in subsequent analyses" (Field 2000), in this case, the structural equation modeling. Thus, this thesis first performs exploratory factor analysis prior to creating a model based on structural equation modeling.

The result of factor analysis "creates a new dimension that can be visualized as classification axes along which measurement variables can be plotted" (Field 2000). The results provide factor loadings, which are the correlation of a latent factor with the original variable. The factor loadings serve as important information as the "substantive importance of a particular variable to a factor" (Field 2000). This information helps naming and interpreting the latent factors, and also selecting right variables that constitute the latent factors.

In the mathematical model of factor analysis, usually p represents the number of variables (*X1, X2,…,Xp*) and m represents the number of latent factors (*F1, F2,…,Fm*). The variable represented in latent factors is denoted as *Xj*. Thus, the assumption here is that each observed variables can be explained by a linear function of m latent factors and a residual variate. In equation, it can be expressed as:

$$X_j = a_{j1}F_1 + a_{j2}F_2 + \cdots a_{jm}F_m + e_j, \qquad (3.1)$$

where $j = 1, 2, \ldots, p$.

$a_{j1}, a_{j2} \ldots a_{jm}$ are the factor loadings. Here, a_{j1} is the factor loading of jth variable on the 1st factor. The unique or specific factor is represented by e_j. As mentioned before, the factor loadings "give us an idea about how much the variable has contributed to the factor; the larger the factor loading the more the variable has contributed to that factor" (Harman, 1976). Correlation coefficient is used as the basic statistic in factor analysis, which represents the relationship between the variables.

In order to find the latent factors, a number of model-fitting methods are available. Maximum likelihood (ML), iterated principal factors, and principal factors with prior estimation of communalities are some of the widely used methods. These methods fit the same model, but each method has advantages and disadvantages. The important advantage of ML is that it provides a wide range of indexes of the goodness of fit of the model. ML also "permits statistical significance testing of factor loadings and correlations among factors and the computation of confidence intervals for these parameters" (Cudeck & O'Dell, 1994). One of the limitations of ML lies in its assumption of multivariate normality. If this assumption is severely violated, distorted results can be produced (Curran, West, and Finch, 1996; Hu, Bentler, and Kano, 1992). Regarding this point iterated principal factor method entails no distributional assumptions. Iterated principal factor is also "less likely than ML to produce improper solutions" (Finch & West, 1997).

Once the model-fitting method is decided, the next step is determining the number of factors to be included in the model. In this thesis, the author follows the method suggested by Hori (2005), which he calls "Hasamikomi-method". In the method, both Minimum Average Partial (MAP) test and parallel analysis are used. MAP tends to underestimate the number of latent factors, while parallel analysis tends to overestimate the number of latent factors. Therefore, by conducting and comparing the results of the both methods, the number of latent factors can be determined paying attention to the interpretation possibility.

After the number of latent factors is determined, factor rotation is performed. By conducting factor rotation, the pattern of the factor loadings will be altered, which helps interpretation. The aim of rotation is "to attain an optimal simple structure which attempts to have each variable load on as few factors as possible, but maximizes the number of high loadings on each variable" (Rummel, 1988). There are mainly two rotation methods: oblique rotation and orthogonal rotation. Orthogonal rotation assumes that the factors are uncorrelated, and the factors are rotated 90° from each other (DeCoster, 1998). This assumption is not realistic considering that factors are usually correlated with each other to some extent (Costello and Osborne, 2005). Oblique rotation assumes that the factors are correlated, and the factors are not rotated 90° from each other. Direct oblimin (DO) and promax are two of the major oblique rotation techniques. Promax "involves raising the loadings to a power of four, which ultimately results in greater correlations among the factors and achieves a simple structure" (Gorsuch, 1983).

Regarding the latent factors, although it depends on the design of the research, some scholars suggest it should have at least 3 variables (Tabachnick and Fidell, 2007). "A factor with 2 variables is only considered reliable when the variables are highly correlated with each another ($r > .70$) but fairly uncorrelated with other variables" (Yong and Pearce, 2013).

In factor analysis, researchers also have to set the cut-off line, which determines a rotated factor loading that is statistically meaningful. In general, the larger sample size allow smaller loadings for a factor to be considered significant (Stevens, 2012). Preceding studies' cut-off line varies from 0.3 to 0.6 (Kokubo et al., 2006; Wolfgang and Manabe, 2013).

For the assessment of model-data fit, two of the commonly reported indices are reported in this thesis; root mean square residual (RMSR) and normed fit index (NFI). NFI "assesses the fit of a model relative to the fit of a null model by scaling the chi-square value from 0 to 1 with larger values indicating better models" (Bentler and Bonett 1980). In general, models with NFI above 0.90 are considered as well-fitting models (Harvey et al. 1985). RMSR "reflects the average residual obtained by taking the difference between the model-generated and sample variance/covariance matrices" (Jöreskog and Sörbom, 1986). In general, RMSR below 0.05 indicates good fit (Byrne, 2012).

Also in the explanatory factor analysis, the adequacy of the sample data will be analyzed using the "Kaiser-Meyer -Olkin Measure of Sampling Adequacy", which compares the partial correlation coefficients to the observed correlation coefficients. For this adequacy analysis, higher values indicate that using a factor analysis is adequate for the data. When the value is less than 0.50, the results have to be treated with caution.

Since the objective of this analysis is to examine the factors driving FDI in wind energy in developing countries, explanatory factor analysis will be performed for two cases: using data of years that country received FDI, and years with no FDI. Considering that both “to invest” and “not to invest” are investment decisions, by comparing results from these two cases the appropriate latent factor structure will be determined. Econometric software Eviews is used for this analysis.

After obtaining the latent factors composed of selected variables, then those are used to create a model based on structural equation modeling.

3.2.2.2 Structural equation modeling

Structural equation modeling is “a comprehensive statistical approach for testing hypotheses about relations among observed and latent variables” (Hoyle, 1995). The goal of structural equation modeling is “to understand the patterns of correlation/covariance among a set of variables and to explain as much of their variance as possible with the specified model” (Kline, 2015). Structural equation modeling and regression look similar in appearance, but they are fundamentally different. There are explicit distinction between independent and dependent variables in a regression analysis. However, structural equation modeling allows a dependent variable in one model equation to become an independent variable in other components of the structural equation modeling system (Bollen, 2009; Kowalski and Tu, 2008). Structural equation modeling not only models the causal relationships between exogenous and endogenous variables, but also among endogenous variables. Models of structural equation modeling can be represented by path diagrams. A path diagram is usually composed of the following: nodes denoting the variables and arrows indicating relations among the variables. By convention, as

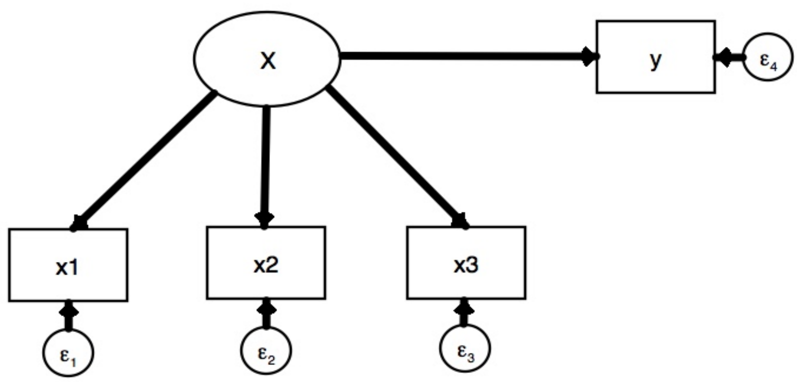


Figure 3.2 Example of path diagram

shown in the Figure 3.2, a circle or ellipse represents latent variables, and a square or rectangle represents observed variables. A causal relation is represented by a single straight arrow. In example, s → d indicates to add β_{ks} to the linear equation for d. β_k is called the path coefficient. A curved two-headed arrow shows that there are some associations between the two variables.

In equations, the figure can be articulated as followings:

$$x_1 = \alpha_1 + \beta_1 X + \varepsilon_1$$
$$x_2 = \alpha_2 + \beta_2 X + \varepsilon_2$$
$$x_3 = \alpha_3 + \beta_3 X + \varepsilon_3$$
$$y = \alpha_4 + \beta_4 X + \varepsilon_4. \qquad (3.2)$$

There are various estimation methods available for estimation of the model. Some of the widely used methods include generalized least squares (GLS), ordinary least squares (OLS), and ML. ML is the most widely used estimation procedure under structural equation modeling approach due to its efficiency. Under the assumption of a multivariate normal distribution of the observed variables, ML method is more consistent, unbiased, and efficient (Kmenta, 1986). In this thesis ML was deployed, therefore the mechanism of the ML is briefly explained. For the estimation of parameter values of a structural equation model, values for the parameters that make the implied covariance matrix as close as possible to the observed covariance matrix are picked. In other words, discrepancy function between the observed covariance matrix and covariance matrix implied by the model needs to be minimized. The values that minimize the maximum likelihood fitting function are the values that maximize the likelihood of the data, which is expressed by the equation below:

$$F_{ML} = \log[\sum(\theta)] + tr\left(S\sum^{-1}(\theta)\right) - \; log[S] - (p+q), \qquad (3.3)$$

where (p + q) represent the number of variables, S represents the observed covariance matrix, and $\sum(\theta)$ represents the implied covariance matrix. In order to minimize the fitting function, numerical methods are used. The algorithm starts with start values (initial guess), and then adjusted based on the change in fitting function with these particular values. The iterative adjustments process is performed until it reaches the minimum of the fitting function.

After the model estimation, model fit has to be evaluated. For the evaluation of model fit, various fit indices have been proposed. In this thesis, some of the most commonly used fit indices are reported, which include: Comparative fit index (CFI), Goodness-of-fit (GFI), Standardized root mean square residual (SRMR), and Root mean square error of approximation (RMSEA).

CFI compares the fit of a model to the data to the fit of another model to the same data. Values of CFI range between 0.0 and 1.0, higher values indicating good fit. Its definition follows:

$$CFI = 1 - \left\{Max\left(\left(x^2_{model} - df_{model}\right), 0\right) / \left(Max\left(x^2_{null} - df_{null}\right), 0\right)\right\}, \qquad (3.4)$$

in which x^2_{model} is the fit of the model tested, and the x^2_{null} is the fit of the model of independence that estimates variances, but no covariance. In order to ensure that miss-specified models are not accepted, Hu and Bentler (1989) recommend a cut-off criterion of CFI ≥ 0.90.

GFI shows how much the tested model is replicating the observed covariance matrix by looking at the variances and covariance (Diamantopoulos and Siguaw, 2000). GFI is explained as:

$$GFI = 1 - \frac{v_{residual}}{v_{total}}, \qquad (3.5)$$

with $v_{residual}$ meaning variance that can't be explained by the model, and v_{total} meaning total variance in the covariance matrix. Values for GFI range between 0.0 and 1.0, higher values indicating good fit. In general GFI ≥ 0.90 indicates the model is in good fit.

SRMR is the square root of the difference between the hypothesized covariance model and the residuals of the sample covariance matrix. The definition of SRMR follows:

$$SRMR = \sqrt{\frac{\sum_{i=1}^{p}\sum_{j=1}^{i}[(s_{ij} - \delta_{ij})/(s_{ii}s_{jj})]^2}{k(k+1)/2}}, \qquad (3.6)$$

where k= p + q. The values for the SRMR range from 0.0 to 1.0 with well fitting models obtaining values less than .05 (Byrne, 2013; Diamantopoulos and Siguaw, 2000), and values as high as 0.08 are deemed acceptable (Hu and Bentler, 1998). The values of SRMR are lower when the number of variables in the model is large, and when the sample sizes are large (500≥). SRMR has an advantage of being relatively less sensitive to other issues such as violations of distributional assumptions (Hu and Bentler, 1998).

RMSEA is "an index that sounds somewhat like the SRMR but it is computed differently and it behaves differently" (Steiger, 2000). RMSEA tells "how well the model, with unknown but optimally chosen parameter estimates would fit the populations covariance matrix" (Byrne, 2013). RMSEA is expressed by:

$$RMSEA = \sqrt{(x^2 - df)/df(N-1)}, \qquad (3.7)$$

in which N is sample size. Unfortunately, when the sample sizes are small (N<250), RMSEA tends to over-reject true models. RMSEA is also sensitive to the number of variables in the model, giving lower-fit for a model with large number of variables (Fan and Sivo 2005; Hu and Bentler, 1998; Kenny and McCoach, 2003).

Considering the sample size in the analysis (N=279), CFI, GFI and SRMR are reported in this thesis.

In structural equation modeling, the model could be modified based on the analysis of the modification indices (MI). Modification indices are score tests (Lagrange multiplier tests) for the statistical significance of the omitted paths (Sorbom, 1989). Establishment of new relations from the MI and exclusion of variables and/or meaningless parameters will be considered only if it is theoretically meaningful to do so.

In this thesis, a model under structural modeling was created with econometric software STATA.

3.3 Results of the Analyses

3.3.1 Explanatory factor analysis

First, exploratory factor analysis was conducted with the data of years that country received FDI, and years with no FDI. Following that the same analysis was conducted for domestic investment.

Regarding the cut-off line for a statistically meaningful rotated factor loading, this thesis sets the cut-off line as 0.6. As Figure 3.3 shows, three mountains of factor loading frequency can be observed with the borders around 0.3 and 0.6. Considering the sample size (N=279), and the result shown in the histogram, the cut-off line 0.6

Table 3.4 Summary of Selected Variables

GDP growth
FDI
Trade Freedom (TF)
Financial Freedom (FF)
Monetary Freedom (MF)
Investment Freedom (IF)
Labor Freedom (LF)
Rule of Law (RoL)
Government Effectiveness (GE)
Political Stability (PS)
Regulatory Quality (RQ)
Control of Corruption (CC)
RE Regulatory
RE Economic
RE Policy

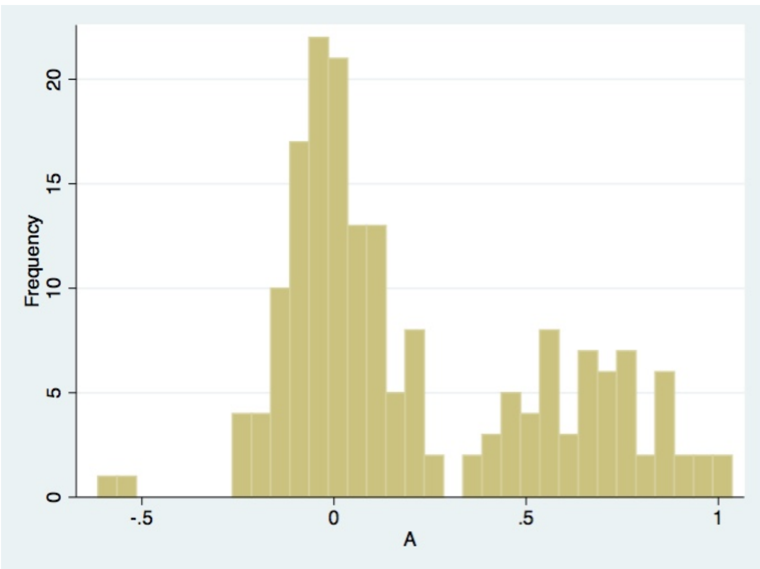


Figure 3.3 Histogram of factor loadings of both FDI and domestic (width: 0.05)

is fairly reasonable (Kokubo et al., 2006; Wolfgang and Manabe, 2013). In the analysis, iterated principal factor method was deployed as a model-fitting method, and oblique (Promax) rotation with Kaiser normalization was performed. A total of 15 variables (Table 3.4), which have been discussed in the section 3.1, are taken into the analysis.

The tables below (Table 3.5 and Table 3.6) show the first results of the factor analysis for the data of years that country received FDI. F1, F2, F3 are latent factors. The sections painted in blue indicate that the factor loading is above the cut-off line. When factor loading of a variable

Table 3.5 EFA Results: Wind Energy FDI

Variables	F1	F2	F3
RE ECONOMIC	−0.085505	0.009089	0.540752
RE POLICY	0.435582	−0.245825	0.028732
RE REGULATORY	0.430772	−0.061407	0.645365
GDP GROWTH	−0.614459	0.034661	0.122153
FDI	−0.189292	0.472027	0.142349
IF	0.739056	0.217177	−0.090377
LF	−0.159685	0.224243	0.659729
MF:	0.636273	0.048214	−0.180088
FF	0.737035	−0.062389	0.097472
TF	0.739532	−0.117523	0.092335
CC	0.037377	0.844912	−0.082868
GE	0.124014	0.653077	0.005471
PS	−0.145556	0.569479	0.121201
ROL	−0.097122	0.922148	−0.010988
RQ	0.511145	0.580841	0.065997

Table 3.6 Correlation between latent factors

Rotated factor correlation: T'T			
	F1	F2	F3
F1	1		
F2	0.46369	1	
F3	0.184048	0.080831	1

is below the cut-off line in all of the latent factors, then they are painted in red. At the end of the table, correlation between the latent factors is presented. Table 3.7 summarizes the Goodness-of-fit and Kaiser's Measure of Sampling Adequacy.

Table 3.7 Goodness-of-fit and Kaiser's Measure of Sampling Adequacy

Root mean sq. resid. (RMSR)	0.086376
Bentler-Bonnet Normed (NFI)	0.932677
Kaiser's Measure of Sampling Adequacy	0.71

The results show that RE Policy, RE Economic, FDI, PS, RQ have factor loadings below the cut-off line 0.6. According to the Kaiser's Measure of Sampling Adequacy, the sample is good enough for the analysis. Regarding the fit indices, NFI is showing acceptable value, whereas RMSR shows value a little above the acceptable line (0.08). Therefore, another analysis with

Table 3.8 EFA Results: Wind Energy FDI - second analysis

Variables	F1	F2	F3
RE_REGULATORY	0.342958	−0.050791	0.643851
GDP_GROWTH	−0.596792	−0.011402	0.058375
IF	0.669047	0.289437	0.018542
LF	−0.187381	0.094348	0.705819
MF	0.645573	0.127651	−0.235924
FF	0.750401	−0.043934	0.088164
TF	0.738386	−0.120997	0.112863
CC	−0.007277	0.937729	0.02504
GE	0.196191	0.669208	−0.067973
ROL	−0.100159	0.93431	0.093744

Table 3.9 Correlation between latent factors

Rotated factor correlation: T'T	F1	F2	F3
F1	1		
F2	0.337906	1	
F3	0.243048	0.160473	1

eliminating the variables that have factor loadings below the cut-off line 0.6 is conducted for the data of years that country received FDI.

Table 3.10 Goodness-of-fit and Kaiser's Measure of Sampling Adequacy

Root mean sq. resid. (RMSR)	0.047952
Bentler-Bonnet Normed (NFI)	0.983357
Kaiser's Measure of Sampling Adequacy	0.710708

In the second analysis, except for the GDP growth, all of the variables have factor loading above the cut-off line. F1 (Latent factor 1) consists of IF, MF, FF, and TF. F2 (Latent factor 2) consists of CC, GE, and RoL. F3 (Latent factor 3) consists of RE Regulatory and LF. Both NFI and RMSR show good fit of the estimation.

Next, Table 3.11 presents the first results of the factor analysis for the data of years that country received no FDI.

The results show that RE Policy, RE Regulatory, GDP growth, FDI, LF, MF have factor loadings below the cut-off line 0.6. According to the Kaiser's Measure of Sampling Adequacy,

Table 3.11 EFA Results: Wind Energy no-FDI

Variables	F1	F2	F3
RE_ECONOMIC	−0.107705	−0.013146	0.67153
RE_POLICY	−0.04336	−0.067378	0.575538
RE_REGULATORY	−0.044245	−0.107608	0.506794
GDP_GROWTH	−0.084255	0.184241	−0.108228
IF	−0.026782	0.77118	−0.043282
LF	0.462494	0.003236	−0.008855
MF	0.197711	0.49944	−0.0397
FF	−0.145065	0.976479	−0.006012
TF	−0.046997	0.714289	−0.032548
FDI	0.439979	−0.068664	−0.221257
CC	0.867109	0.064007	0.0394
GE	0.795113	0.116515	0.10054
PS	0.839249	−0.21921	−0.136871
ROL	0.862775	0.096151	0.106475
RQ	0.38088	0.69326	0.007489

Table 3.12 Correlation between latent factors

Rotated factor correlation: T'T	F1	F2	F3
F1	1		
F2	0.548922	1	
F3	0.333182	0.408459	1

Table 3.13 Goodness-of-fit and Kaiser's Measure of Sampling Adequacy

Root mean sq. resid. (RMSR)	0.963375
Bentler-Bonnet Normed (NFI)	0.978025
Kaiser's Measure of Sampling Adequacy	0.771423

the sample adequacy is over 0.7, which is good enough for the analysis. NFI showed good fit but RMSR showed barely acceptable fit. Therefore, same as the analysis with the data of years that country received FDI, another analysis with eliminating the variables that have factor loadings below the cut-off line 0.6 is conducted. The results show that all the analyzed variables

Table 3.14 EFA Results: Wind Energy no-FDI – second analysis

Variables	F1	F2	F3
RE_ECONOMIC	−0.03607	0.027948	0.628569
IF	0.007555	0.715878	0.011372
FF	−0.149105	1.016894	0.00282
TF	−0.01548	0.690516	−0.0517
CC	0.928767	0.018882	0.003455
GE	0.862995	0.084752	0.044224
PS	0.74313	−0.181095	−0.122483
ROL	0.912808	0.077389	0.062862
RQ	0.440082	0.653338	−0.014918

Table 3.15 Correlation between latent factors

Rotated factor correlation: T'T	F1	F2	F3
F1	1		
F2	0.535077	1	
F3	0.246177	0.300132	1

have factor loadings above 0.6. Fit indices show good fit of the estimation.

Table 3.16 Goodness-of-fit and Kaiser's Measure of Sampling Adequacy

Root mean sq. resid. (RMSR)	0.038924
Bentler-Bonnet Normed (NFI)	0.991581
Kaiser's Measure of Sampling Adequacy	0.771423

Table 3.17 Latent factors and constructs in the case of FDI.

F1: Institutional Environment	F2: Macroeconomic Environment
CC	TF
RoL	FF
GE	IF

Considering that both "to invest" and "not to invest" are investment decisions, by comparing results from these two cases the appropriate latent factor structure is determined. Based on the results, only the variables that have factor loadings above the cut-off line in both cases are selected as variable that consists the final latent factors and their constructs.

The Table 3.17 shows the final result in the case of FDI. F1 consists of control corruption, rule of law, and government effectiveness. F2 consists of trade freedom, financial freedom, and

Table 3.18 EFA Results: Wind Energy domestic investment

	F1	F2	F3
RE_ECONOMIC	-0.020086	-0.042849	0.561846
RE_POLICY	-0.15997	0.260737	0.224572
RE_REGULATORY	0.050357	0.228363	0.704263
GDP_GROWTH	0.020356	-0.526779	-0.050231
IF	0.2061	0.771219	-0.201445
LF	0.253823	-0.171824	0.431824
MF	-0.049646	0.642056	-0.013759
FF	-0.068091	0.721828	0.153463
TF	0.061523	0.746568	-0.06023
FDI	0.221227	0.002981	0.037617
CC	0.978166	-0.062472	-0.083565
GE	0.734961	0.033027	0.099645
PS	0.562344	0.152896	0.00114
ROL	1.020735	-0.142173	0.030116
RQ	0.543649	0.536013	0.071894

Table 3.19 Correlation between latent factors

Rotated factor correlation: T'T

	F1	F2	F3
F1	1		
F2	0.50396	1	
F3	0.119705	0.137367	1

Table 3.20 Goodness-of-fit and Kaiser's Measure of Sampling Adequacy

Root mean sq. resid. (RMSR)	0.056221
Bentler-Bonnet Normed (NFI)	0.974448
Kaiser's Measure of Sampling Adequacy	0.746867

investment freedom. Considering the constructs of the latent factors, latent factor 1 (F1) is named institutional environment, and latent factor 2 (F2) is named macroeconomic environment.

In the same manner, the explanatory factor analysis was conducted for the case of domestic investment for wind energy in developing countries. Table 3.18 shows the results of the analysis with the data of years countries had domestic investments. The results show that RE policy, RE economic, GDP growth, FDI, LF, PS, and RQ have factor loadings below the cut-off line 0.6.

Table 3.21 EFA Results: Wind Energy no-domestic investment

Variables	F1	F2	F3
RE_ECONOMIC	−0.044182	0.038171	0.602125
RE_POLICY	−0.015982	−0.01398	0.562041
RE_REGULATC	−0.104391	−0.083753	0.593646
GDP_GROWTH	−0.095994	0.1789	−0.128356
IF	−0.063389	0.747978	0.053098
LF	0.439773	0.067404	−0.007666
MF	0.196715	0.532417	−0.03223
FF	−0.134665	0.989432	−0.014653
TF	−0.070205	0.7176	−0.047012
FDI	0.362958	−0.07245	−0.148285
CC	0.887954	0.041498	0.028995
GE	0.835687	0.122744	0.012847
PS	0.805793	−0.238917	−0.051844
ROL	0.878611	0.088218	0.086461
RQ	0.39865	0.684857	−0.012486

Table 3.22 Correlation between latent factors

Rotated factor correlation: T'T

	F1	F2	F3
F1	1		
F2	0.536245	1	
F3	0.326184	0.392819	1

Table 3.23 Goodness-of-fit and Kaiser's Measure of Sampling Adequacy

Root mean sq. resid. (RMSR)	0.056094
Bentler-Bonnet Normed (NFI)	0.974961
Kaiser's Measure of Sampling Adequacy	0.764904

The sampling adequacy is high enough with the value of 0.747, NFI showed good fit and RMSR showed acceptable fit with the value of 0.056.

Succeeding to the next analysis, the table below presents the results of the analysis with the data of years countries didn't have domestic investments

The results show that RE policy, RE regulatory, GDP growth, FDI, LF, and MF have factor loadings below the cut-off line 0.6. The sampling adequacy shows good value, and NFI indicates good fit. Although not a good fit, RMSR shows acceptable fit of the value below 0.8.

Comparing the results of the analysis with the data of years countries had domestic investments, and years countries had no domestic investment.

Based on the results, only the variables that have factor loadings above the cut-off line in both cases are selected as variable that consists the final latent factors and their constructs.

The Table 3.24 shows the final result in the case of domestic investment, which is identical to the results of FDI. Same as the case of FDI, considering the constructs of the latent factors, latent factor 1 (F1) is named Governance, and latent factor 2 (F2) is named Business Environment.

Table 3.24 Latent factors and constructs in the case of domestic investment

F1: Institutional Environment	F2: Macroeconomic Environment
CC	TF
RoL	FF
GE	IF

Table 3.25 Summary of variables for FDI and domestic investment

F1: Institutional Environment	F2: Macroeconomic Environment	Exogenous Variables
CC	TF	RE Economic
RoL	FF	RE Regulatory
GE	IF	GDP Growth

Although RE economic and RE regulatory showed factor loadings above 0.6 in only one of the analysis (years with investments, and years with no investments) in both FDI and domestic investment cases, considering theoretical and empirical importance of these factors (Birte and Peter, 2013; Carley, 2009), these factors will be taken into the analysis of structural equation moiling as exogenous variables. Similarly, GDP growth, which is a great indicator for the market potential, will be taken into the analysis as exogenous variable considering its importance as a FDI driver (Erdal and Mahmut, 2008; Khan and Nawaz, 2010). RE policy didn't have loading factors over the cut-off line in any of the analyses. Considering that policy support for renewable energy have empirically tested to have marginal effect on the diffusion of the renewable energy in developing countries according to the study conducted by Birte and Peter (2013), and also, those high renewable energy target and plans of the developing countries are often deemed doubtful lacking feasibility (Dornan, 2012), it is reasonable not to include RE Policy in the succeeding analysis. The final structure of the variables that will be taken into the analysis in the structural equation modeling is summarized in Table 3.25.

3.3.2 Structural equation modeling

Means, standard deviations, and Pearson correlations for the measurement scales are presented

Table 3.26 Means and standard deviations for measurement scales in the SEM models

Variable	Obs	Mean	Std. Dev.	Min	Max
projects	280	0.6464286	1.476211	0	9
capacity	280	27.16752	74.96776	0	604
RERegulatory	280	0.4	0.4907751	0	1
REEconomic	280	0.475	0.5002687	0	1
GDPgrowth	280	3.553278	3.147155	−7.820885	10.63171
TF	280	74.47036	12.94037	0	88.6
IF	280	49.91071	19.73142	0	90
FF	280	47.75	14.98894	10	70
CC	280	47.14402	20.90086	11.48325	91.38756
RoL	280	48.13928	19.17792	7.582938	88.46154
GE	280	54.36607	17.5621	16.74641	90.38461

Table 3.27 Correlations for measurement scales in the SEM models

Variable	1	2	3	4	5	6	7	8	9	10	11
1 capacity	1										
2 projects	0.7976	1									
3 RERegulatory	0.394	0.473	1								
4 REEconomic	0.2954	0.3981	0.508	1							
5 GDPgrowth	−0.1215	−0.0672	−0.2163	−0.046	1						
6 TF	0.1836	0.1599	0.2333	0.249	−0.1062	1					
7 IF	0.2584	0.2173	0.2128	0.1768	−0.0961	0.5164	1				
8 FF	0.1788	0.2069	0.2933	0.253	−0.1475	0.6441	0.6743	1			
9 CC	0.0209	0.0135	0.1559	0.1135	−0.1126	0.2984	0.4641	0.3606	1		
10 RoL	0.0487	0.0704	0.1844	0.1918	−0.0971	0.3316	0.4967	0.425	0.9019	1	
11 GE	0.0418	0.0723	0.1546	0.2437	−0.0755	0.3558	0.3747	0.473	0.8488	0.8631	1

in Table 3.26 and Table 3.27. Based on the results of the explanatory factor analysis, the author developed a structural equation model including latent variables institutional environment and macroeconomic environment, and variables RE Economic, RE Regulatory, GDP growth, capacity, and projects. Capacity indicates the amount of wind energy plant capacity invested, and projects mean the number of investment projects. Structural equation modeling is developed both with capacity and projects, since both variables can be considered as proxy for investors' investment decision. Therefore, first the results of the structural equation modeling in the case of FDI in wind energy in developing countries are presented, and next the case of domestic investment are presented to further analyze the FDI drivers in wind energy in developing countries by comparing them with one another.

In the structural equation modeling, the models are developed based on the following

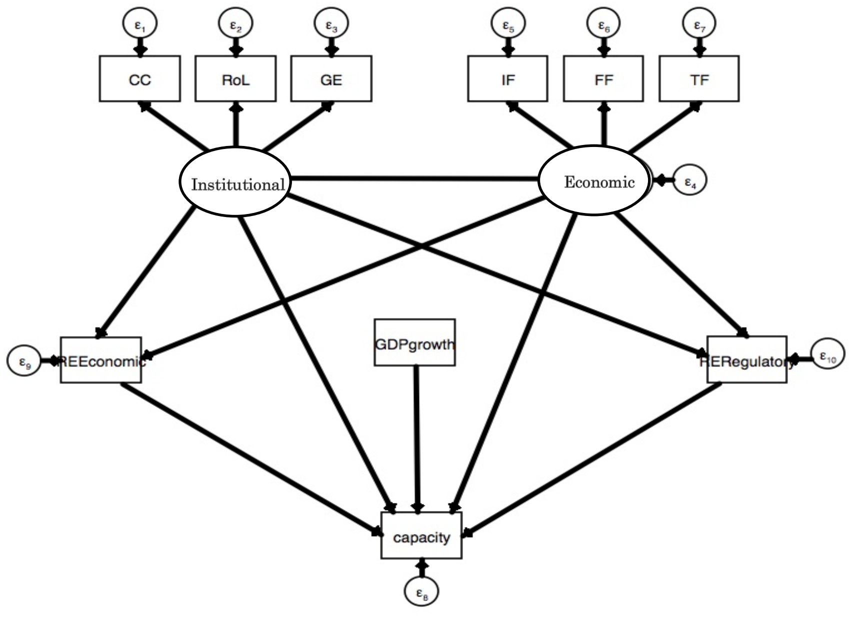


Figure 3.4 Hypothesized structural equation model

hypothesis:

1) Countries with better institutional environment receive more investments
2) Countries with better macroeconomic environment receive more investments
3) Existence of regulatory support and economic support for renewable energy attracts more investments
4) Bigger market potential attracts more investments
5) Better institutional environment promotes better macroeconomic environment
6) Countries with better institutional environment, better macroeconomic environment are opt to employ regulatory and economic support for renewable energy

The hypothesis 1)~4) are based on the theories and preceding studies discussed in the section 2.1 and 3.1. The hypothesis 5) is based on the argument that country's investment environment is determined to a great extent by its institutional environment (Côté and Healy, 2001). Similarly, the effect of better institutional environment and better macroeconomic environment on the deployment of regulatory and economic support for renewable energy is tested.

The Figure 3.4 depicts the hypothesized structural equation model in the case of taking capacity

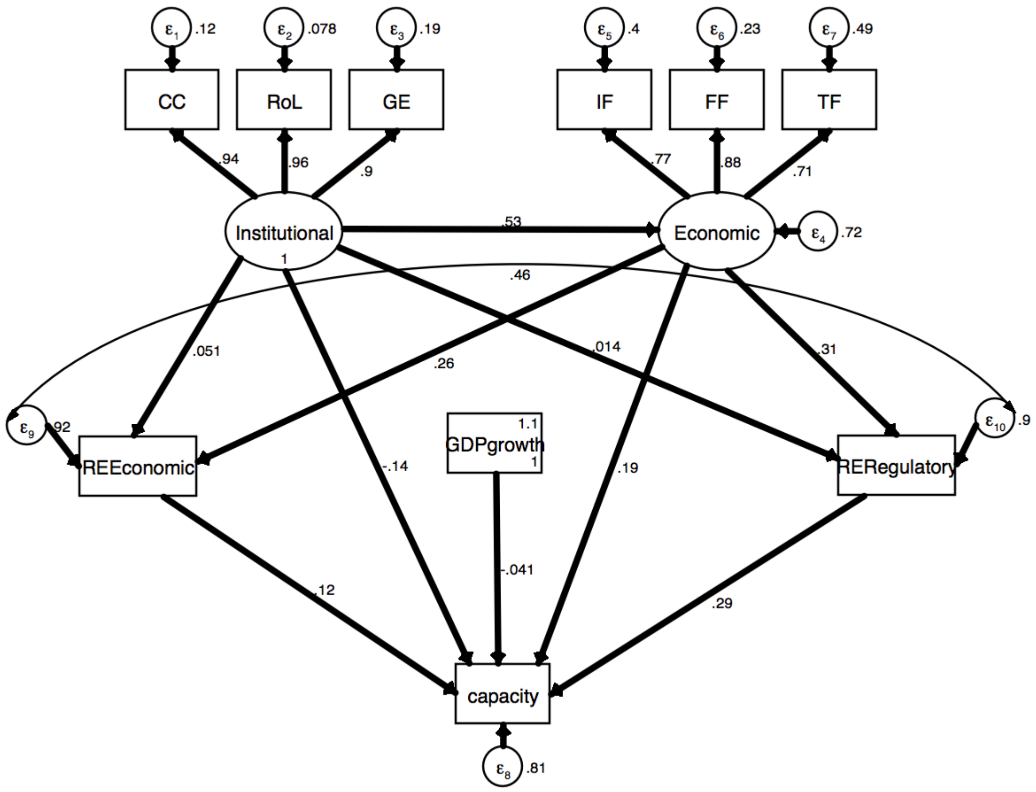


Figure 3.5 Structural model of FDI drivers with Capacity as dependent variable

Table 3.28 Goodness-of-fit measures for the structural

CFI	0.911
GFI	0.912
SRMR	0.057

Table 3.29 P-value for each path

i	j	p-value
Economic	Institutional	0
RE Regulatory	Economic	4.44E-16
RE Regulatory	Institutional	0.691621
RE Economic	Economic	2.54E-11
RE Economic	Institutional	0.157848
TF	Economic	0
IF	Economic	0
FF	Economic	0
CC	Institutional	0
RoL	Institutional	0
GE	Institutional	0
capacity	Economic	1.08E-06
capacity	Institutional	5.78E-05
capacity	RE Regulatory	0
capacity	RE Economic	0.000193
capacity	GDP growth	0.141187

as a dependent variable.

First, the Figure 3.5 shows the result of the analysis of a model in the case of FDI with having capacity as dependent variable. As it can be observed in the correlation results, RE Economic and RE Regulatory correlate high with the value 0.508. In this model, the curved arrow is placed between residuals of RE economic and RE regulatory. This can be justified considering that the correlation between the two can be interpreted as the “willingness to support renewable energy” of the government.

The goodness of fit measures for the structural model show acceptable fit in all of the three indices. Table 3.29 presents the statistical significance for each path depicted in the developed model. The result shows that paths from institutional environment to RE economic and RE regulatory are statistically insignificant. Furthermore, the path from GDP growth to capacity is also insignificant; showing that market potential is not a strong determinant for FDI in wind energy in developing countries based on this model.

The number next to each arrow in the Figure 3.5 indicates the mean standardized structural and

Table 3.30 Total effect (sum of direct and indirect effect) of each variable on capacity

Total Effect: Standarlized	Economic	Institutional	RE Regulat	RE Econom	TF	IF	FF	CC	RoL	GE	GDP growth	capacity
Economic	1	0.533591	0	0	0	0	0	0	0	0	0	0
Institutional	0	1	0	0	0	0	0	0	0	0	0	0
RE Regulator	0.310767	0.18011	1	0	0	0	0	0	0	0	0	0
RE Economic	0.256819	0.188374	0	1	0	0	0	0	0	0	0	0
TF	0.711262	0.379523	0	0	1	0	0	0	0	0	0	0
IF	0.773578	0.412774	0	0	0	1	0	0	0	0	0	0
FF	0.875547	0.467184	0	0	0	0	1	0	0	0	0	0
CC	0	0.937964	0	0	0	0	0	1	0	0	0	0
RoL	0	0.960049	0	0	0	0	0	0	1	0	0	0
GE	0	0.902769	0	0	0	0	0	0	0	1	0	0
GDP growth	0	0	0	0	0	0	0	0	0	0	1	0
capacity	0.310239	0.036931	0.290671	0.119177	0	0	0	0	0	0	−0.041024	1

measurement weights. It shows that institutional environment has strong effect on the economic and RE regulatory support. Taking these indirect effects into account, the total effect of each variable on invested capacity is summarized in the Table 3.30. In terms of the direct effect, the Figure 3.5 shows that RE regulatory, macroeconomic environment, and RE economic have meaningful effect on the capacity. Combining the indirect effect, macroeconomic environment has the largest effect, followed by RE regulatory and RE economic. The direct effect of institutional environment to capacity shows a very small but negative effect with statistical significance (p<0.001). The implication of this result is that lower levels of institutional

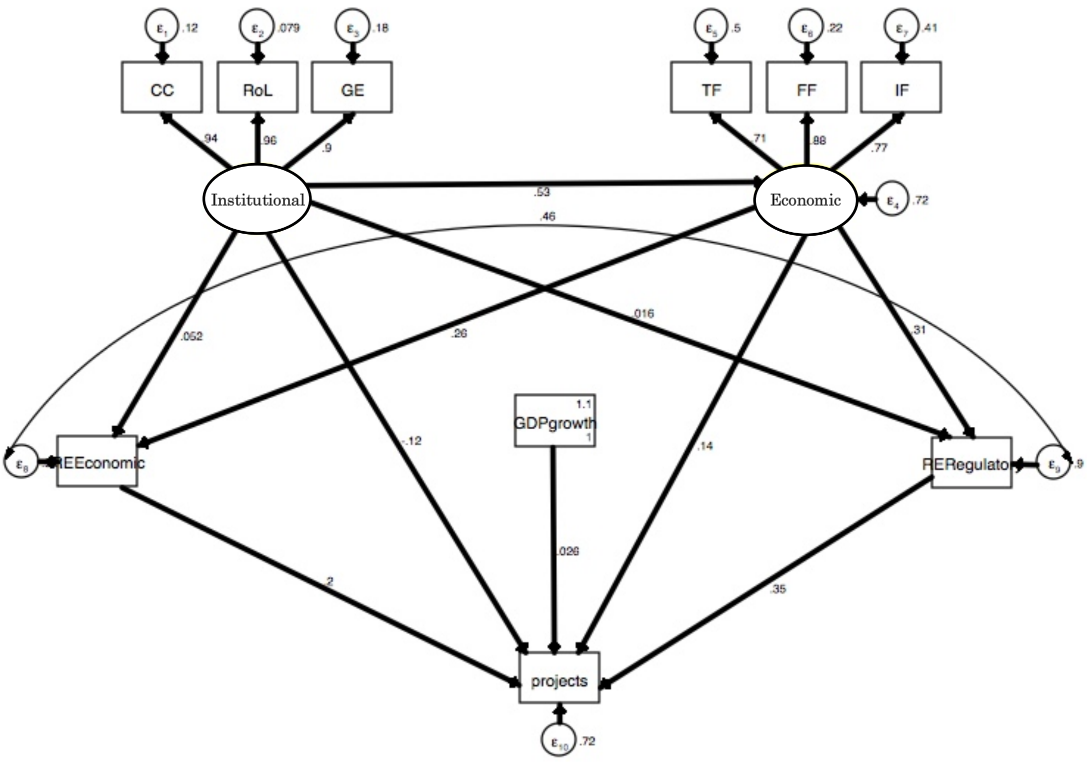


Figure. 3.6 Structural model of FDI drivers with projects as dependent variable

environment will lead to more deals. Although this result is questionable from theoretical standpoint, since the effect is very small (value: -0.14), it is better to interpret this result as institutional environment having less to none effect on the investment decision. This is the same even if the indirect effect is taken in account, which makes the total effect of institutional environment as 0.04.

Next, a similar model is developed with taking projects as dependent variable (Figure 3.6). Table 3.31 shows that the model has acceptable fit in all of the three measures. Statistical significance for each path (Table 3.32) showed similar result as the case of FDI with capacity as dependent variable; institutional environment to RE economic and RE regulatory, and GDP growth to projects are insignificant. Regarding the direct effect of each variable, the results are mostly the same as the one with capacity as a dependent variable. However, it is noteworthy that even combining direct effect and indirect effect, RE regulatory, a renewable energy specific variable holds the strongest effect on the number of projects.

Table 3.31 Goodness-of-fit measures for the structural equation model

CFI	0.916
GFI	0.915
SRMR	0.057

Table 3.32 P-value for each path

i	j	p-value
Economic	Institutional	0
RE Regulatory	Economic	2.22E-16
RE Regulatory	Institutional	0.664785
RE Economic	Economic	2.15E-11
RE Economic	Institutional	0.14795
TF	Economic	0
IF	Economic	0
FF	Economic	0
CC	Institutional	0
RoL	Institutional	0
GE	Institutional	0
projects	Economic	7.96E-05
projects	Institutional	0.000265
projects	RE Regulatory	0
projects	RE Economic	2.04E-11
projects	GDP growth	0.319057

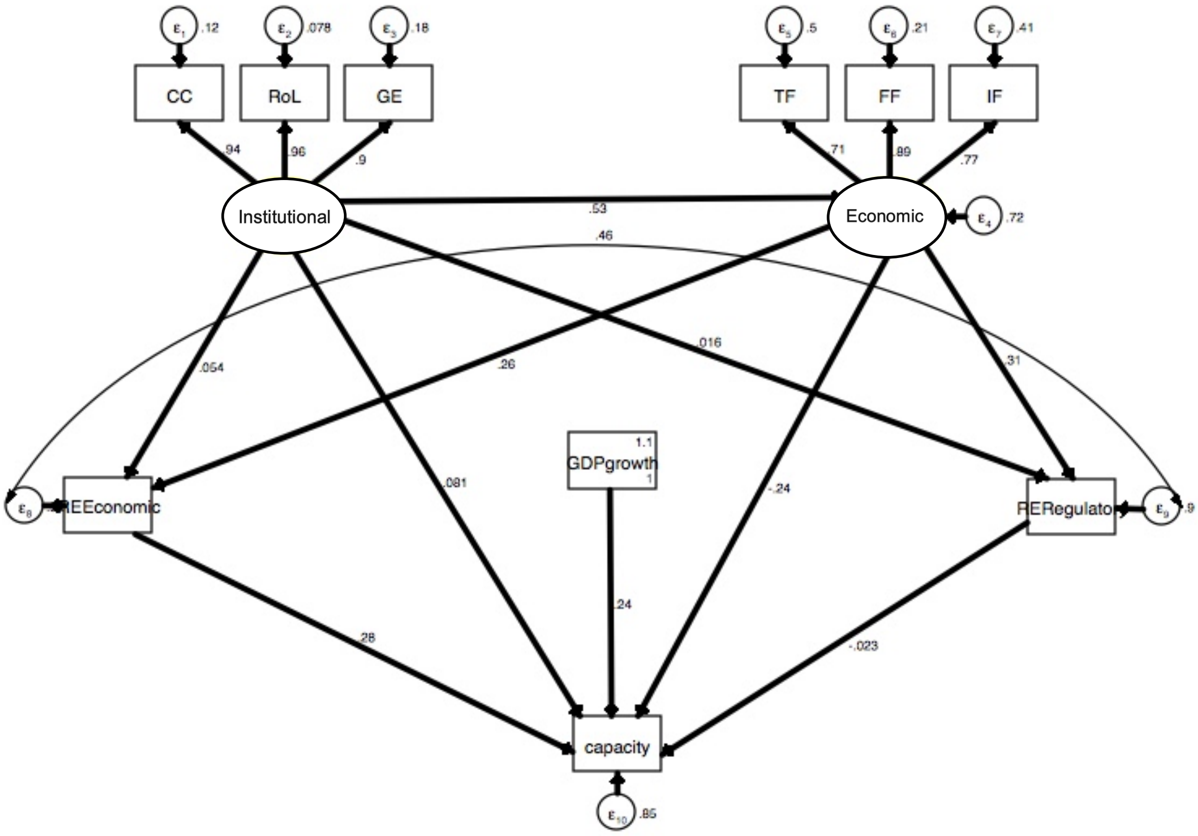


Figure 3.7 Structural model of domestic investment drivers with Capacity as dependent variable

Next, results of the case of domestic investment are presented (Figure 3.7) to further analyze the

Table 3.33 Total effect (sum of direct and indirect effect) of each variable on projects

Total Effect: Standarlized	Economic	Institutional	RE Regulat	RE Econon	TF	IF	FF	CC	RoL	GE	GDP growt	projects
Economic	1	0.53026	0	0	0	0	0	0	0	0	0	0
Institutional	0	1	0	0	0	0	0	0	0	0	0	0
RE Regulator	0.310236	0.180053	1	0	0	0	0	0	0	0	0	0
RE Economic	0.256205	0.188252	0	1	0	0	0	0	0	0	0	0
TF	0.709774	0.376364	0	0	1	0	0	0	0	0	0	0
IF	0.767501	0.406975	0	0	0	1	0	0	0	0	0	0
FF	0.882838	0.468134	0	0	0	0	1	0	0	0	0	0
CC	0	0.93825	0	0	0	0	0	1	0	0	0	0
RoL	0	0.95976	0	0	0	0	0	0	1	0	0	0
GE	0	0.902844	0	0	0	0	0	0	0	1	0	0
GDP growth	0	0	0	0	0	0	0	0	0	0	1	0
projects	0.301645	0.058687	0.351056	0.202029	0	0	0	0	0	0	0.026213	1

Table 3.34 Goodness-of-fit measures for the structural equation

CFI	0.911
GFI	0.912
SRMR	0.057

FDI drivers in wind energy in developing countries by comparing each other. Measures of goodness to fit of the model (Table 3.34) show that the model's fit is above the acceptable level. Concerning the statistical significance for each path, same as the case of FDI, the paths from institutional environment to RE economic and RE regulatory are statistically insignificant. In contrast to the case of FDI, the path from RE regulatory to capacity is also statistically insignificant.

It is interesting that GDP growth, which had statistically insignificant effect on both capacity and projects, has significant and strong effect on capacity in the case of domestic investment. This has further confirms that the market potential is not an important variable in the case of

Table 3.35 P-value for each path

i	j	p-value
Economic	Institutional	0
RE Regulatory	Economic	2.22E-16
RE Regulatory	Institutional	0.647588
RE Economic	Economic	2.18E-11
RE Economic	Institutional	0.138459
TF	Economic	0
IF	Economic	0
FF	Economic	0
CC	Institutional	0
RoL	Institutional	0
GE	Institutional	0
capacity	Economic	8.73E-10
capacity	Institutional	0.020741
capacity	RE Regulatory	0.503698
capacity	RE Economic	0
capacity	GDP growth	0

Table 3.36 Total effect (sum of direct and indirect effect) of each variable on capacity

Total Effect: Standarlized	Economic	Institutional	RE Regulatory	RE Economic	TF	IF	FF	CC	RoL	GE	GDP growth	capacity
Economic	1	0.528835	0	0	0	0	0	0	0	0	0	0
Institutional	0	1	0	0	0	0	0	0	0	0	0	0
RE Regulatory	0.30975	0.180178	1	0	0	0	0	0	0	0	0	0
RE Economic	0.255357	0.188595	0	1	0	0	0	0	0	0	0	0
TF	0.707597	0.374202	0	0	1	0	0	0	0	0	0	0
IF	0.765331	0.404734	0	0	0	1	0	0	0	0	0	0
FF	0.886623	0.468878	0	0	0	0	1	0	0	0	0	0
CC	0	0.937508	0	0	0	0	0	1	0	0	0	0
RoL	0	0.960325	0	0	0	0	0	0	1	0	0	0
GE	0	0.902933	0	0	0	0	0	0	0	1	0	0
GDP growth	0	0	0	0	0	0	0	0	0	0	1	0
capacity	-0.17354	0.003526	-0.0226145	0.27756603	0	0	0	0	0	0	0.2416442	1

Table 3.37 Goodness-of-fit measures for the structural

CFI	0.908
GFI	0.91
SRMR	0.057

FDI in wind energy in developing countries. In the case of domestic investment, RE economic has the strongest effect on the investment decision, followed by GDP growth. It is notable that although existence of regulatory support for renewable energy has the strongest effect on investment decision in the case of FDI, in the case of domestic investment regulatory support is rather statistically insignificant and the existence of economic support is the most important factor. Another point is that institutional environment has positive direct effect with the value of 0.81. Although the weight is not strong, this is indicating that countries with better institutional environment have more domestic investments in wind energy.

Finally, the results of the case of domestic investment with projects as dependent variable are presented (Figure 3.8). As shown in the Table 3.37, the model has above the line of acceptable fit in all of the three goodness to fit measures. Table 3.38 shows that the statistical significance of paths from institutional environment to RE economic and RE regulatory are, the same as

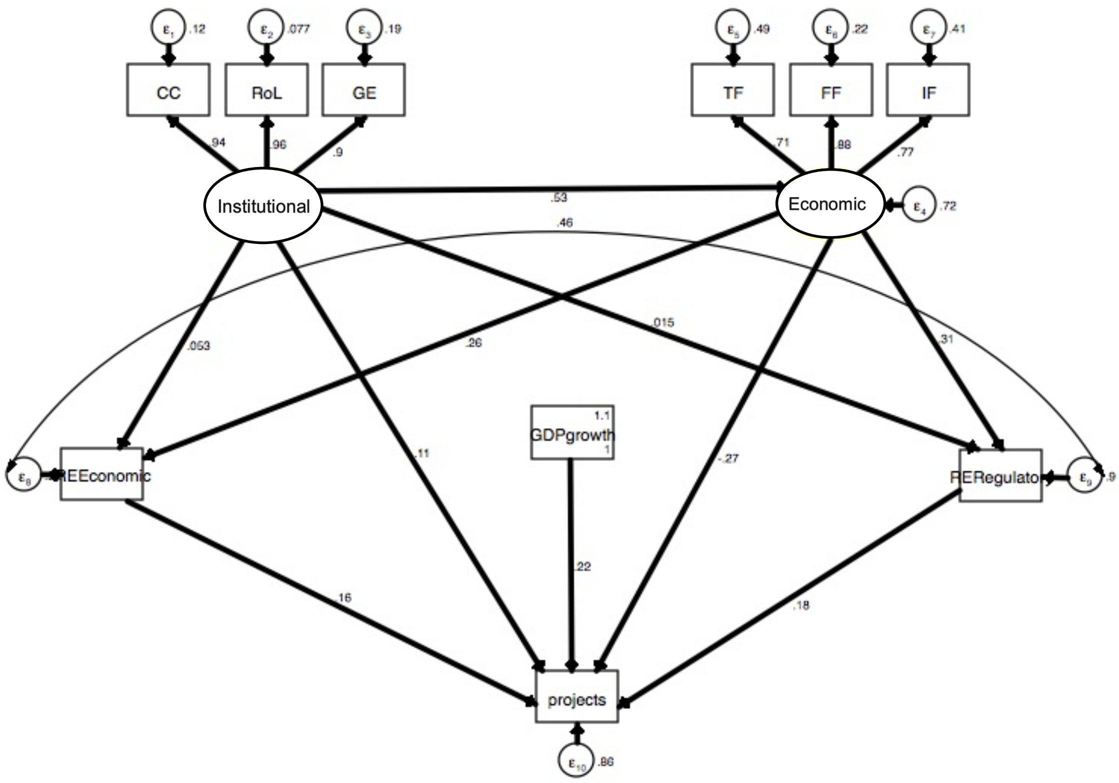


Figure 3.8 Structural model of domestic investment drivers with Projects as dependent variable

Table 3.38 P-value for each path

i	j	p-value
Economic	Institutional	0
RE Regulatory	Economic	4.44E-16
RE Regulatory	Institutional	0.667587
RE Economic	Economic	2.12E-11
RE Economic	Institutional	0.147685
TF	Economic	0
IF	Economic	0
FF	Economic	0
CC	Institutional	0
RoL	Institutional	0
GE	Institutional	0
	Economic	
projects	Institutional	1.12E-11
projects	Governance	0.002732
projects	RE Regulatory	1.35E-07
projects	RE Economic	2.42E-06
projects	GDP growth	2.69E-14

Table 3.39 Total effect (sum of direct and indirect effect) of each variable on projects

Total Effect: Standerlized	Economic	Institutional	RE Regulat	RE Econon	TF	IF	FF	CC	RoL	GE	GDP growth	projects
Economic	1	0.53100306	0	0	0	0	0	0	0	0	0	0
Institutional	0	1	0	0	0	0	0	0	0	0	0	0
RE Regulatory	0.310501	0.1802949	1	0	0	0	0	0	0	0	0	0
RE Economic	0.256691	0.18875429	0	1	0	0	0	0	0	0	0	0
TF	0.714773	0.37954679	0	0	1	0	0	0	0	0	0	0
IF	0.765887	0.40668813	0	0	0	1	0	0	0	0	0	0
FF	0.880508	0.46755242	0	0	0	0	1	0	0	0	0	0
CC	0	0.9370609	0	0	0	0	0	1	0	0	0	0
RoL	0	0.96095585	0	0	0	0	0	0	1	0	0	0
GE	0	0.90252953	0	0	0	0	0	0	0	1	0	0
GDP growth	0	0	0	0	0	0	0	0	0	0	1	0
projects	−0.17137	0.02604113	0.178908	0.155385	0	0	0	0	0	0	0.2187255	1

other analyses, statistically insignificant.

Although the path from RE regulatory to capacity showed an insignificant effect, in the case of projects RE regulatory has a statistically significant and positive effect on the investment decision. Similar to the case of capacity, RE economic and GDP growth have strong and statistically significant effects on the investment decision. Macroeconomic environment, similar to the case of capacity, has a negative effect. This is questionable from theoretical point of view, but it is possible that a country employs economic support for renewable energy as an industrial strategy although having a low quality business environment. This requires more in depth analysis with case studies.

3.4 Summary of Chapter 3

Renewable energy sector is one of the fastest growing sectors attracting great amount of FDI. Considering the importance of this sector, and the great FDI allocation differences in renewable energy among developing countries observed from the data obtained from GlobalData (2016), this chapter looked at how the determinants in this sector are different from the traditional determinants by focusing on wind energy in developing countries using econometric approaches. Determinants include theoretically argued and empirically tested variables and renewable energy sector specific determinants. After conducting exploratory factor analysis, the variable constructed two latent factors: institutional environment and macroeconomic environment. Thereafter, adding renewable energy specific variable as exogenous variables, structure equation modeling has been conducted. By comparing the results of the case of FDI and domestic investment, the following points are highlighted:

- Economic support for renewable energy has strong and significant effect on investment decision in both FDI and domestic investment cases.
- Regulatory support for renewable energy is especially important for foreign investors, whereas for domestic investment economic support has stronger effect than regulatory support.
- Traditional FDI determinants, such as access to finance, trade openness, and general investment restrictions still have strong effect on investment decision for foreign investors.
- Institutional environment has weak effect on the investment decision of foreign investors.
- Countries with growing market have more domestic investment. However, market potential has statistically insignificant effect on investment decision for foreign investors.

4. Determinants of FDI in RE in Developing Countries – Qualitative Approach

As presented in Chapter 3, the econometric analysis of the determinants of FDI in wind energy in developing countries clarified that renewable energy support policies have equivalent or greater effect compared to the widely accepted determinants such as corruption level, price stability, access to finance, and GDP growth. Although the econometric approach provides important empirical evidences, there are also some limitations. For example, based on the econometric approach, renewable economic support policies hold strong impact on location decisions of the FDI. Renewable economic support policies include different kinds of support policies such as feed-in tariff, competitive bidding, renewable energy certificates and renewable portfolio standards, and tax-incentives. In the econometric approach, these different support policies' impacts are not individually tested but instead dummy variable takes value 1 from the first year of implementation of one of the aforementioned renewable economic support policies. This limitation is due to the condition that a lot of countries implement more than one support policies in parallel, which makes it hard to clarify the impact of each policy.

Another limitation lies in the selection of appropriate variables. In order to conduct the econometric study, variables were selected based on literature review and availability of data. Painuly (2001) stresses that interaction with practitioners in the field through structured interviews and/or questionnaires is "very crucial to identification of the barriers as the perception of stakeholders on barriers may reveal the lacunae in existing policies and help in identification of measures to overcome the barriers". If practitioners' opinions are more reflected, there could be some other factors that act as important location determinants of FDI in renewable energy.

Therefore, in order to overcome this limitation, and to verify and complement the results of the econometric approach, a study using qualitative approach is conducted. This study aims to identify the determinants of FDI in renewable energy, and the relative importance of the determinants based on semi-structured interviews and questionnaires conducted with practitioners active in the field of FDI in wind and solar energy in developing countries. The relative importance of the determinants are clarified through analyzing the data obtained through the questionnaires using analytic hierarchy process. Clarifying the relative importance of the determinants offers criteria for prioritizing policies and actions that can lead to enhancement of a country's attractiveness for obtaining FDI in renewable energy, and further shows the importance of sector-specific policies.

4.1 Methods

First, in order to identify potential determinants of FDI in renewable energy, a thorough literature review on determinants of FDI is conducted. A review of empirical studies on determinants of FDI in general is already conducted and presented in Chapter 2. Thus in this chapter, renewable energy sector specific studies are thoroughly reviewed to identify additional sector specific determinants. While there are plenty of empirical studies on determinants of FDI in general, the number of studies on the determinants of FDI in the renewable energy sector is very limited. Thus, preceding studies related to determinants, barriers, and drivers of investment in the renewable energy sector are reviewed.

Next, in order to reflect the opinions of practitioners and verify the importance of the factors identified through the literature review, semi-structured interviews were conducted with experts in wind and solar energy investment (hereafter referred to as "experts"). Following the studies that use expert opinions including the one by Kuhnert et al. (2010), the term experts is defined as someone having specialist knowledge acquired through practice, or experience. In this study, practitioners who are in the decision-making positions in large multinational companies that are active in the field of wind and solar energy are interviewed as experts. Although the number of semi-structure interviews (*n*=7) is not large, when the interviewees of a study are all considered to be well-defined experts in the field, even 5 interviewees are considered to be sufficient as suggested by Krueger et al. (2012). The interviewees are carefully selected to be less biased considering the headquarters of the companies and the targeted sectors (wind and solar energy), and the investment experiences of the companies. A detailed description of the experts is provided in Table 4.1. The names of the interviewees are kept anonymous in this study in consideration of the sensitivity of the subject.

In the semi-structured interviews, each factor that was identified through the literature review was explained in detail to the interviewees using the interview material (see Appendix B) in order to create a common understanding. Then the interviewees were asked to provide opinions on the importance of each factor based on their experiences. In order to narrow down the important factors, the interviewees were also asked to point out factors that were not considered to be significant enough to be included as determinants. The interviews were conducted via phone or video call using Skype, interview length being around 1 to 2 hours. All interviews took place between November 2016 and June 2017.

Table 4.1 Description of the interviewees

Company	Headquarter	Sector	Investment experiences (developing economies)	Interview date
Company A	Japan	PV and wind	Chile, Peru, Philippines, Mexico, and South Africa	November 16th, 2016
Company B	Korea	PV and Wind	Hungary, Malaysia, Poland, and Turkey	March 10th, 2017
Company C	Japan	PV and Wind	Chile, Malaysia, Philippines, Thailand, and United Arab Emirates	March 13th, 2017
Company D	Japan	PV	Kenya, South Africa, and Tanzania	March 30th, 2017
Company E	United States	PV and Wind	Chile, Romania, South Africa, and United Arab Emirates	June 8th, 2017
Company F	Japan	PV and Wind	Mongolia, Morocco, South Africa, UAE, and Poland	June 15th, 2017
Company G	United Kingdom	PV and Wind	Algeria, Chile, Peru, South Africa, and Uruguay	June 16th, 2017

Finally, in order to set the priorities among the determinants that have been identified, experts in decision-making positions in companies that are active in FDI in wind and solar energy were asked to fill out questionnaires formulated to provide input for the prioritization process. The responses are analyzed using the Analytic hierarchy process method (AHP) to finalize the prioritization process. AHP is a tool used for decision making and determining the significance of a set of criteria and sub-criteria of multi-criteria problems. The AHP method was developed by Thomas Saaty in 1980 (Saaty, 1980). The AHP method is very suitable for complex social issues in which intangible and tangible factors cannot be separated (Lee and Chatt, 2008). Due to its simplicity, flexibility and ease of use, AHP is widely applicable in various fields, and it has been employed in number of cases related to renewable energy (Bhatt et al., 2010; Demirtas, 2013; Kaya and Kahraman, 2010; Nigim et al., 2004). Most of the literature applying AHP to cases related renewable energy are using AHP in order to determine the best renewable energy to be deployed in the certain region or environment. Therefore, there are hardly any cases applying AHP in order to determine the significance of determinants of FDI in renewable energy, which is considered to be another originality of this thesis.

In AHP, first the problem is structured in a hierarchical model by creating various levels of Issues-Categories Parameters to achieve the desired goal. In the case of this thesis, the top of the hierarchy is the objective of the study: “Enhancement of Attractiveness for FDI in Renewable Energy ”, and below that are broad categories and the factors (sub-categories). Then decision makers systematically evaluate the various elements by comparing them to one another two at a time with respect to their impact on an element above them in the hierarchy using 1-9 scale as proposed by Saaty (Saaty, 1980). The 1-9 scale is explained in more detail in Table 4.2. These evaluations made by decision makers will be converted to numerical values that can be processed and compared over the entire range of the problem. First, the pairwise judgments made by the experts will be converted into a pair-wise matrix. The normalized matrix is gained by dividing each element by the column-wise summation of the elements. Then, the eigen-vector is calculated by averaging the element in rows. Each element of this vector represents the weight of importance. In this study, the average of evaluations made by the experts is presented as priority (relative significance) of each factor. Next, consistency of each pairwise comparison matrix is checked in order to justify the evaluations made by the experts. Measuring the inconsistency of pairwise comparison matrix is an important issue in the Analytic Hierarchy Process. The oldest and most commonly used measure is the consistency index (CI) and consistency ratio (CR) (Brunelli et al., 2013). CI is calculated based on the following equation proposed by Saaty (1980):

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad , \qquad (4.1)$$

n: number of evaluating factor.

λ_{max}: the maximum eigen-value of the matrix.

Table 4.2 Analytic Hierarchy Measurement Scale (Saaty, 1980)

Reciprocal Measure of Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Moderate importance	Experience and judgment strongly favor one activity over another
7	Strong importance	An activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between two adjacent judgments	When compromise is needed

CR is defined as:

$$CR = \frac{CI}{RI}, \qquad (4.2)$$

RI is the average value of CI obtained from 500 positive reciprocal pairwise comparison matrices whose entries were randomly generated using the 1 to 9 scale. Table 4.3 gives values of the average RI for different values of n.

Table 4.3 Values of the random index for different matrix orders (Saaty, 1980)

n	1~2	3	4	5	6	7
RI	0	0.58	0.90	1.12	1.24	1.32

If CR = 0, then the answers of the respondent is completely consistent; if CR = 1, then the answers are completely inconsistent. In general, based on Saaty's suggestion, answers within CR ≤ 0.1~0.15 are considered consistent enough to be acceptable (Saaty, 1980). When CR is above 0.15, it is recommended to repeat the evaluation till it reaches the acceptable consistency. However, in real practice, a comparison matrix often has poor consistency and repeating the evaluation numerous times are practically difficult. Bhushan and Rai (2007) suggest that for very abstract parameters, CR up to 0.2 should be allowed. In fact, a large number of preceding studies used 0.2 instead of 0.1 as CR criterion (Regmi and Hanaoka, 2012; Thao et al., 2014). In this thesis, a CR criterion of 0.2 was used, and answers (pairwise comparisons) with CR ≥ 0.2 were excluded as inconsistent.

Next, all of the pairwise comparisons that meet the consistency defined above are combined into consolidated decision matrix to get the aggregated group result using eigenvector method. Aggregation of individual judgments is done using the weighted geometric mean of the decision matrices elements $a_{ij(k)}$ using the individual decision maker's weight (ω_k), which is expressed as the following:

$$C_{ij} = exp\frac{\sum_{k=1}^{n}\omega_k \mathrm{In} a_{ij(k)}}{\sum_{k=1}^{n}\omega_k}, \qquad (4.3)$$

Through the above-mentioned process, a numerical weight or priority is derived for each element of the hierarchy, which allows the elements to be compared with one another in a rational and consistent way.

Adding to the weight of each element of the hierarchy, consensus ratio among the respondents is calculated using Shannon alpha and beta entropy. The consensus indicator ranges from 0% (no consensus between decisions makers) to 100% (full consensus between decision makers). AHP consensus ratio *S* is calculated based on the following equation:

$$S = \left[M - \exp\left(H_{\propto min}\right)/\exp\left(H_{\gamma max}\right)\right]/\left[1 - \exp\left(H_{\propto min}\right)/\exp\left(H_{\gamma max}\right)\right], \qquad (4,4)$$

with
$$M = 1/\exp\left(H_{\beta}\right), \qquad (4.5)$$

$H_{\alpha,\beta,\gamma}$ is the α, β, γ Shannon entropy for the priorities of all K respondents.

Shannon alpha entropy:

$$H_{\propto} = \frac{1}{K}\sum_{j=1}^{K}\sum_{i=1}^{N} - p_{ij}\ln p_{ij}, \qquad (4.6)$$

Shannon gamma entropy:

$$H_{\gamma} = \sum_{j=1}^{K} - \overline{p_{J}}\ln \overline{p_{J}}, \qquad (4.7)$$

with
$$\overline{p_{J}} = \frac{1}{N}\sum_{i=1}^{N} p_{ij}, \qquad (4.8)$$

Shannon gamma entropy:

$$H_{\beta} = H_{\gamma} - H_{\propto}, \qquad (4.9)$$

The result of the consensus ratio is reported for each category and sub-category. AHP Excel spreadsheet developed by Goepel (2013) was used for the calculation of AHP.[3]

AHP is a subjective method that is not necessary to involve a large sample, but rather useful for research focusing on a specific issue where a large sample is not mandatory (Cheng and Li, 2002; Lam and Zhao, 1989). Thus, when only the relevant experts are selected as respondents, AHP analysis is suitable to be conducted with a small sample. For example, in order to test comparability of critical success factors for construction partnering, Cheng and Li (2002) used 9 experts' answers to conduct AHP analysis. Similarly, Lam and Zhao (1989) used 8 experts' answers for AHP analysis for a quality-of-teaching survey.

In this study, the questionnaire (Appendix C) was sent to experts in decision-making positions in multinational companies that are active in FDI in wind and solar energy. The companies were identified based on generation plant database provided by GlobalData (2016), and only the companies who have been involved in wind or solar energy projects with more than 1MW capacity were selected in order to exclude small-scale investment. The questionnaire was sent to a total number of 86 companies, which the author was able to contact experts in decision-making positions directly via email, and 19 responses were obtained. Through evaluating the consistency ratio of the collected questionnaires, 18 questionnaires showed to have acceptable consistency (Table 4.4), and are used for the analysis.

[3] The template can be downloaded from: (http://bpmsg.com/new-ahp-excel-template-with-multiple-inputs/)
A detailed description of the template is provided in the following pdf document:
(http://bpmsg.com/wp-content/uploads/2014/01/AHPcalc-v2013-12-24a.pdf)

Table 4.4 Consistency ratio values for the judgment matrices of each respondent

Question	Respondent																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Categories	0.1	0.05	0.11	0.1	0.09	0.07	0.11	0.03	0.11	0.13	0.1	0.07	0	**0.15**	0.05	0.06	0.07	0.04	0.04
Instituional	0.14	0.03	0.09	0	0.04	0.14	0.02	0.09	0.08	0.14	0	0.14	0	0.02	0	0.01	0	0.02	0.02
Macroeconomic	0.01	0.07	0.14	0.12	0.14	0.1	0.03	0.06	0.1	0.14	0.14	0.06	0.14	**0.37**	0.14	0	0.12	0.06	0.14
Natural conditions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Renewable policies	0.07	0.02	0.14	0.12	0	0.09	0.03	0.09	0.13	0.03	0	0.14	0.12	0.06	0.06	0.06	0.01	0.03	0.1
Renewable economic	0.01	0.12	0.01	0.12	0.1	0.11	0.02	0.12	0.11	0.11	0.02	0.1	0.13	**0.19**	0.09	0.09	0.1	0.01	0.07
Renewable regulatory	0.05	0.06	0	0	0.14	0.03	0.04	0.02	0.01	0	0	0	0.14	0.1	0	0.03	0.08	0.11	0.02
Renewable political	0.06	0	0.14	0.07	0	0	0.1	0.06	0.02	0	0	0.14	0	0	0.1	0	0	0.14	0.14

Table 4.5 Description of the respondents

Respondent	Headquarter	Sector
Respondent 1	United States	PV and wind
Respondent 2	France	PV and Wind
Respondent 3	United States	PV
Respondent 4	United Kingdom	PV
Respondent 5	Egypt	PV and Wind
Respondent 6	Japan	PV and Wind
Respondent 7	Egypt	PV
Respondent 8	Italy	PV and Wind
Respondent 9	China	PV and Wind
Respondent 10	Ireland	PV and Wind
Respondent 11	Japan	PV and Wind
Respondent 12	Japan	PV and Wind
Respondent 13	France	PV and Wind
Respondent 14	Japan	PV
Respondent 15	Egypt	PV
Respondent 16	Germany	PV and Wind
Respondent 17	Indonesia	PV and Wind
Respondent 18	Japan	PV and Wind
Respondent 19	Korea	PV and Wind

A detailed description of the experts who provided responses to the questionnaire is provided in Table 4.5. The names of the interviewees are kept anonymous in this study in consideration of the sensitivity of the subject. The respondents are all highly experienced experts of oversea investment in renewable energy projects, around three-fourth of the respondents being involved in both solar and wind energy.

4.2 Literature Review of Studies on Determinants of Investment in Renewable Energy

This section presents the result of literature review of preceding studies on barriers and determinants of investment in renewable energy in order to narrow down the determinants of FDI in wind and solar energy in developing countries.

International Energy Agency (IEA)/International Renewable Energy Agency (IRENA) Joint Policies and Measures Database covers renewable energy policy measures deployed at country-level, covering both IEA member countries and non-IEA countries (IEA/IRENA Joint Policies and Measures Database, 2016). The database classifies renewable energy policies into economic instruments, policy support, regulatory instruments, information and education, research, development and deployment, and voluntary approaches. Based on the classification of the database, renewable energy determinants used in this thesis will be grouped into the following three categories: economic support policies, regulatory support policies, and political support policies.

The following studies are the studies that look in to the determinants of investment in renewable energy using quantitative approaches.

Eyraud et al. (2013) investigate determinants of green investment (including both domestic and foreign inward investment), which they define as investment in renewable energy, selected energy-efficient technologies, and research and development in green technologies, over the last 10 years for 35 advanced and emerging economies. The study concludes that low interest rates, economic growth, high fuel prices, and policy interventions including economic support policies such as feed-in-tariffs have positive impact on green investment. Feed-in tariff is a policy tool adopted in various countries and facilitated rapid spread of wind energy and solar energy in a lot of countries, which offers a guaranteed price for electricity generated by renewable energy with a purchase obligation by the utilities for a fixed long-time period contracts ranging from 10 to 20 years (Jacobsson and Lauber, 2006).

Murovec et al. (2012) examine the determinants of environmental investments (including investments into renewable energy) using structural equation modeling, and find that financial incentives, tax measures, and regulations act as strong determinants. Keeley and Ikeda (2017) also use structural equation modeling to investigate the determinant of FDI in wind energy in developing countries. They find renewable energy policies work as strong determinants, and clarify that especially regulatory support policies (including guaranteed access to grid and technical standard) have strong impact on investment decisions of foreign investors.

Ang (2016) provides empirical evidences on the impacts of various renewable energy policies drawing on an econometric analysis, and conclude that feed-in tariff system contributes to attracting FDI, but local content requirements in wind and solar energy decrease the effectiveness of feed-in tariff system and negatively affect FDI.

Menanteau et al. (2003) investigate the relative efficiency of the different economic support policies. They classify the support policies into quantity-focus ones, which set national targets and set up a competitive bidding or setting quota system with renewable energy certificate trading policies, and price-focus policies such as feed-in tariffs. They compare these policies both from a theoretical approach by comparing price-based approaches with quantity-based approaches, and a practical approach by investigating the actual impact of the policies in selected European countries. The study indicates that a feed-in tariffs system is more efficient than a competitive bidding system, and asserts that the real efficiency of renewable energy certificate system is unclear in situations where information is incomplete.

Romano et al. (2017) investigate the effectiveness of renewable energy policies, using a panel of 56 countries with different social, political and economic characteristics. The policies are categorized into regulatory policies, fiscal incentives, and public investments. Their effects on renewable energy investment are investigated using econometric analysis with panel-corrected standard error estimates, which shows that not all policies facilitate investments in renewable energy, and the effectiveness of the policies depends on the stage of development of the countries. Although the study doesn't directly focus on FDI, their results provide empirical support for focusing specifically on developing countries in this research.

These studies empirically show that renewable support policies, especially economic support policies such as feed-in tariff, and regulatory support policies such as guaranteed access to grid hold strong importance on location decision of FDI in renewable energy.

Compared to the studies using quantitative approaches, there are a large number of studies that are dealing with barriers and drivers of investment in renewable energy using qualitative approaches.

Painuly (2001) develops an analysis framework for identifying barriers to renewable energy penetration, and suggests measures to overcome them. Painuly categorizes broad ranges of barriers to diffusion of renewable energy into market failure/imperfection, market distortions, economic and financial, institutional, technical, social, cultural and behavioral categories. Some of the barriers that are highly relevant to determinants of FDI include: lack of access to capital, lack of a legal/regulatory framework, unstable macro-economic environment, lack of standard and codes and certification, lack of social acceptance, lack of infrastructure, uncertain governmental policies.

Jones (2015) investigates how investors perceive barriers to clean energy infrastructure investment by conducting semi-structured interviews and workshops, and identifies policy certainty, overall governance in countries, and limitations in support infrastructure including transport and grid infrastructure as strong barriers.

Pîrlogea (2011) reviews investment barriers to renewable energy primarily focusing on Romania, and classifies the barriers into: administrative barriers, technological and technical barriers, market barriers, and economic barriers. Some of the major barriers identified through the review include obtaining authorization and permits, corruption and lack of transparency, access to grid infrastructure, and high initial investment.

Abdmouleh et al. (2015) examine different types of renewable support policies through case studies of both successful and failed experiences of various countries. They conclude that feed-in tariff, auction, priority access to grid, renewable energy target, and renewable energy development plan have shown successful impact on diffusion of renewable energy. Auction is a call for running competitive bidding for predetermined quantity of renewable energy under long-term power purchase agreements. Renewable energy development plan refers to a mid- to long-term strategic framework for promoting installation of renewable energy. Regarding economic support policies, the study provides supportive argument for feed-in tariff systems, but also points out that tariffs are not always easy to determine at the beginning, especially in developing countries, and recommends initially having competitive bidding system to discover the adequate price before applying feed-in tariff system. They also shed light on the importance of strong political support at national, regional or local levels, through smooth bureaucratic application procedures, target setting, and development planning.

Zeng et al. (2017) review the problems and solutions of renewable energy development in BRICS countries, especially focusing on financial aspects. The study asserts that the lack of financing channels and investment shortages in small and medium-sized enterprises are impeding development of renewable energy in these countries. The authors claim the need for the development of a financial market for renewable energy. They argue that the renewable energy sector is still perceived as a risky and uncertain sector in the BRICS countries compared to other developed counties and commercial banks are not confident enough to allocate their limited funds in the sector with low-interest rates.

These studies that employ qualitative approaches including literature review, case studies, and semi-structured interviews strengthen the argument that regulatory support policies such as priority access to grid are important in facilitating renewable energy investment. Furthermore, these studies also shed light on the importance of economic support policies other than feed-in tariff such as competitive bidding, and also stress the importance of political support policies including having renewable energy target and well-structured development plan.

Table 4.6 provides summary of the literature review of studies on barriers and determinants of investment in renewable energy.

Table 4.6 Summary of the literature review of studies on renewable energy investments

Category		Factor	Reference
Renewable energy policies	Economic support policies	Feed-in tariff	Abdmouleh et al., 2015; Ang, 2016; Eyraud et al., 2013; Jacobsson and Lauber, 2006; Keeley and Ikeda, 2017
		Renewable portfolio standards and renewable energy certificates	Menanteau et al., 2003; Romano et al., 2017
		Auction/competitive bidding	Abdmouleh et al., 2015; Lewis and Wiser, 2007; Mourelatou et al., 2001; Romano et al., 2017
		Tax incentives	Mourelatou et al., 2001; Romano et al., 2017; Murovec et al., 2012
	Regulatory support policies	Priority/guaranteed access to grid	Abdmouleh et al., 2015; Bechberger, 2004; Jones, 2015; Keeley and Ikeda, 2017; Mourelatou et al., 2001; Pîrlogea, 2011
		Absence of local content	Ang, 2016
	Political support policies	National renewable energy target	Abdmouleh et al., 2015; Reiche and Bechberger, 2004
		Well-structured renewable energy development plan	Abdmouleh et al., 2015; Foxon and Pearson, 2008
		Social acceptance	Eleftheriadis and Anagnostopoulou, 2015; Painuly, 2001; Pîrlogea, 2011; Reiche and Bechberger, 2004

4.3 Expert Opinion – Semi-structured Interviews

This section presents the determinants of FDI in wind and solar energy in developing countries that have been narrowed down from the factors identified through the literature review (Table 2.1 and Table 4.6) based on the semi-structured interviews. Some of the factors that were perceived as less important factors by the experts are not included in this section as determinants of FDI in wind and solar energy in developing countries. Each determinant is explained in light of preceding studies, and expert opinions obtained through the semi-structured interviews. All of the opinions obtained through the semi-structured interviews are cited as "(*Company X*)", which corresponds to Table 4.1, in order to distinguish them from citations of academic articles.

In the semi-structured interviews, the interviewees were also asked to point out factors that were not considered to be significant enough to be included. Then the factors that were raised by more than four experts were removed from the determinants of FDI in wind and solar energy. Experts were also asked to provide any other factor that could be an important location determinant, but no additional critical factors were suggested to be included by the experts. In fact, it was suggested that critical factors could be narrowed down to a smaller number, which we followed in our practice. Table 4.7 provides the summary of the removed factors and the number of experts who raised the factors as less important determinants

Table 4.7 Summary of the literature review of studies on renewable energy investments

Category	Removed Factor	Number of experts who raised the factor
Institutional environment	Corruption	4
Macroeconomic environment	Geographical proximity	7
	Market size	6
	Tax rate (corporate)	5
	Infrastructure	6
Natural conditions	Risk of disaster	5

4.3.1 Institutional environment

Political risk

Diamonte et al. (1996) show, using analyst estimates of political risk, "that average returns in emerging markets experiencing decreased political risk exceed those of emerging markets experiencing increased political risk by approximately 11 percent a quarter" and further clarifies that there are statistically significant differences regarding the effect of political risk between developed and developing countries. Countries with high political risk are perceived as a great risk to implementing wind and solar energy projects since they can cause sudden changes to renewable energy policies (*Company F*). Developing countries need to decrease political risk in order to provide sense of security to conduct wind and solar energy projects in the countries.

Rule of law

Hoff and Stiglitz (2005) argue that the presence of rule of law is an important factor that protects future returns, and affects the long-term value of assets. Foreign companies become confident if the law is functioning well, which makes it possible to sue the government or any other related stakeholders if there are any legal issues (*Company A*). From the investor side, when investing in developing countries, it is considered safer to obtain funding from domestic government development/export bank for safety backup (*Company C*). Establishing a well-functioning rule of law is important to create the necessary climate of stability and predictability for foreign investors.

Efficient and transparent administrative procedure

A lot of studies assert that inefficient administrative procedures can be time-consuming and absorb personnel, and lead to increase in up-front expenses (Loy and Coviello, 2005). Companies have experienced several cases in developing countries where they had to wait for more than 3 years after winning the competitive bidding due to very slow administrative procedure (*Company E*). Another point raised by some of the experts was the importance of the quality of administrative procedure of local governments. Local governments often have great influence over companies, issuing local operating permits, and having communities that directly affect business operations of the companies in the region (Evans and Hamner, 2003), which has been the case in FDI in wind and solar energy, too (*Company F*). Especially for the developing countries with less experience in implementing renewable energy projects, it would be beneficial to establish a one-stop agency that could guide investors through the stages of administrative process, including planning, application for approval, approval procedure and project implementation. The one-stop agency could also provide support for the utilization of Clean Development Mechanism when applicable.

4.3.2 Macroeconomic environment

Access to local finance

Developed financial markets may make financing short- and long-term transactions easier for foreign firms, which helps foreign firms to reduce the exposure to the exchange rate risk. However, wind and solar energy projects require a large up-front capital cost but small variable cost, thus the relative importance of easy access to local finance is low (*Company B*). In a lot of the cases with competitive bidding, the guaranteed revenue will be paid in US dollars, which makes getting funding from host country not that important. However, in some cases, the tariff is paid in domestic currency even for competitive bidding projects, which makes access to local finance important (*Company D*). Adding to this, obtaining funding from a local bank could enhance the credibility of the company in the country, and help the smooth implementation of the project (*Company G*). Providing the guaranteed revenue in US dollars will boost the confidence of foreign investors especially for countries with less developed financial markets.

Exchange rate volatility

Continuous fluctuations of exchange rate indicate currency instability of a country. For risk-averse investors, exchange rate volatility can be regarded as additional cost, which could discourage FDI. The stability of exchange rate is recognized as one of the most important factors besides renewable energy policies especially because of the following reasons: the long-term payback period of wind and solar energy projects makes currency volatility a factor that negatively affects investors' decisions (*Company B*); wind and solar energy projects are perceived to serve as low-volatility investment in a lot of companies' investment portfolio, thus a stable exchange rate is preferred (*Company C*). Therefore, host countries need to avoid over-valuation of the exchange rate for maintaining a stable economic environment (Kiyota and Urata, 2004).

Labor cost

The installation segment, which is labor-intensive, is the largest segment in the solar value chain regarding employment in the sector. Similar to solar energy projects, around 70% of total jobs of wind energy sector in the US were created in downstream activities including installation and sales (55,200 out of 80,700; AWEA, 2011). However, since the relative cost of labor to hardware (turbines and PV modules etc.) is low, labor cost is a less important factor when choosing investment location (*Company E*).

4.3.3 Natural conditions

Natural resources

Natural resource endowment has been long time perceived as strong determinants of FDI (Anyanwu, 2012). In fact, most of the interviewed experts emphasized availability of natural resources as one of the prerequisites for choosing a country to conduct solar and/or wind energy projects. Although solar energy is widely available around the world, annual solar radiation ranges between 750 kWh/m^2 and 2500 kWh/m^2 in various parts of the world (Shoubi and Shoubi, 2013). Similarly, wind speed varies greatly between different locations, and what times of day and what times of year the wind is most likely to blow could greatly vary, too. These differences could directly impact the revenue of wind and solar energy projects by changing the amount of electricity that could be generated, and also indirectly impact the projects through influencing the ease/difficulty of grid integration. Therefore, when choosing a country to implement a wind and solar energy project, companies attach great importance to the availability of natural resources as much as the expected electricity sales price set through feed-in tariff, renewable energy certificates, or competitive biddings (*Company F*). This also means that accumulation of detailed data regarding wind speed and solar radiation in a country will create an attractive environment for foreign investors.

Access to land

Some countries place land-purchase restrictions for foreign companies, which sometimes make projects infeasible to implement, or force changes in business structure such as shifting to joint venture with local companies. Because of the site-specific nature of wind and solar energy resources, securing stable and reliable access to land is one of the most important factors that affect project feasibility (*Company E*). Slow administrative procedures for securing land can be often observed in a lot of developing countries, and it can drive up the cost of the projects greatly (*Company D*).

4.3.4 Renewable energy policies

4.3.4.1 Economic support policies

Feed-in tariff

Although Feed-in tariff system is raised as a very attractive system by most of the experts, the attractiveness of the system depends on the guaranteed price and trustworthiness of the system. For the system to be trustworthy, the cost structure can be important factor: it is safer when the cost of the system is covered through electricity tariff paid by the consumer of the host country. Spain is a good case showing the risk of having the cost of the system covered by the government: sudden boom in investment put pressure on the government budget, which eventually led to sudden change in the feed-in tariff system (Couture and Gagnon, 2010; *Company B*).

Renewable energy certificates and renewable portfolio standards

Renewable energy certificates (REC) are often used in combination with renewable portfolio standards (RPS), which oblige electricity producers and/or distributors to either buy or produce fixed amount of electricity generated with renewable energy (Menanteau et al., 2003). REC allows competition between renewable producers since the price of certificate depends on supply and demand of certificates (Abdmouleh et al., 2015). From the perspectives of foreign investors, this volatility in the price of certificate increases the volatility of the revenue of projects, and this will make the country less attractive for conducting a project especially when combined with high volatility in exchange rate (*Company D*).

Auction/competitive bidding

Competitive bidding has became popular in recent years, and a large number of countries prefer competitive bidding to feed-in tariff policies due to its controllability by the government. More than 64 countries had held competitive bidding by the end of 2015, and record bids in terms of both price and volume occurred in developing countries (REN21, 2017). While competitive bidding facilitates development of specific technologies since it allows competition within technologies, aggressive competitions among developers of the projects and often time-consuming tendering process make the system hard to provide long-term market stability or profitability (Mourelatou et al., 2001).

The experts consider auction as a system that has both advantages and disadvantages compared to other popular systems including feed-in tariff. In case of Auction, although the competition could be quite severe, it is mostly the case that government provides close support for the company that wins the bidding for smooth development of the project, which makes it easier for foreign companies since foreign companies sometimes encounter difficulties in dealing with permits and other regulatory issues in the host country (*Company B*). However, considering that the competition is getting too severe, especially for solar energy projects, lowering the return on the investment rate, it is questionable if competitive bidding is a long-term support policy that a country can hold successfully (*Company C*). This point has also been raised by Lewis and Wiser (2007), stating that competitive bidding "has historically not provided long-term market stability or profitability, due in part to the often uncertain or long lead times between tenders and the fierce competition among project developers to win the competitive process".

Tax incentives

Tax exemptions or reductions can encourage private individuals and companies to consider investing in wind and solar energy projects. These incentives can come in the form of capital- or production-based income tax deductions or credits, accelerated depreciation, property tax incentives, sales or excise tax reductions, and value-added tax reductions. As with financial incentives, tax-based incentives are generally found to play a supplemental role to other policies, and countries that have relied heavily on tax-based strategies (e.g., US and India) have often been left with unstable markets for wind power (Lewis and Wiser, 2007). However, especially in developing countries, since wind and solar energy FDI projects are mostly conducted under special purpose company, tax exemptions provide little benefit (*Company C*).

4.3.4.2 Regulatory support policies

Priority/guaranteed access to grid

Most of the experts raise guaranteed access to grid as a critical factor for implementing solar and wind projects. For small-scale energy projects, the logistics and cost of grid connection can significantly drive up the cost of the projects, thus it is critical to provide priority access to electricity grid for independent power producers to distribute their electricity (Mourelatou et al., 2001). Especially for investors coming from outside the host country, transparent and straightforward access to the grid would be essential for smooth and secured project development. Since in most of the cases, FDI wind and solar energy projects are implemented with project finance, which require guaranteed flow of revenue, if there are any risks in grid connection that affects the future revenue of the project, the company would not be able to obtain finances for the project (*Company A*). With competitive bidding, it is often the case that access to grid infrastructure is guaranteed, but in other cases access to grid could be challenging in some countries (*Company E*).

Technical standards

Setting technical standards that are aligned with international standards is important for proper function of technical systems as long as the standard does not mandate specific standards that only benefit domestic firms. However, countries are increasingly using technical standards as an industrial policy tool to limit foreign companies' participation in their wind energy and solar energy markets (Stepp and Atkinson, 2012). There were cases where companies gave up investment in wind energy projects since there were technical standards that require wind turbines to be larger than specific size or to contain domestic parts for the turbines (*Company C*). Technical standards that are not aligned with international standards could drive up costs and act as a de facto market-access barrier. Therefore, foreign companies would prefer investing in a country having technical standards that are aligned with international standards.

Absence of local content requirement

Most of the experts expressed that the existence of local content requirement (LCR) is a critical factor that strongly and negatively affects wind and solar energy FDI projects. When there is LCR, it forces foreign companies to choose the supplier of turbines/panels from the companies in the host country, which often drives up the cost (*Company E*). Also, for choosing a reliable supplier that provides continuous support for more than 20 years, LCR greatly reduces the freedom of selection (*Company D*).

4.3.4.2 Political support policies

National renewable energy target

Renewable energy targets could be laid out both for long term as well as for short term based on the needs and feasibility in each country, which could be an indicator for investors regarding the degree of commitment of government. Reiche and Bechberger (2004) show that for some countries the strong political support with feasible and ambitious national renewable energy target is an important basis that ensures security of energy supply and to reduce their imports of fossil fuels and the use of coal. However, targets serve as a good indicator for the market provision of the host country only if it seems feasible and supported by a well-structured development plan (*Company E*). Targets are especially trustworthy when there is a system that penalizes if the host country fails to attain the target (*Company F*).

Well-structured renewable energy development plan

A stable and consistent strategic framework encourages investment in renewable energy for the long term (Foxon and Pearson, 2008). Development plans provide great confidence for foreign investors especially when it includes establishment of a renewable energy institution that can act as a one-stop agency when conducting a wind and solar energy projects, and addresses land-usage issues and grid the infrastructure development plans (*Company C*).

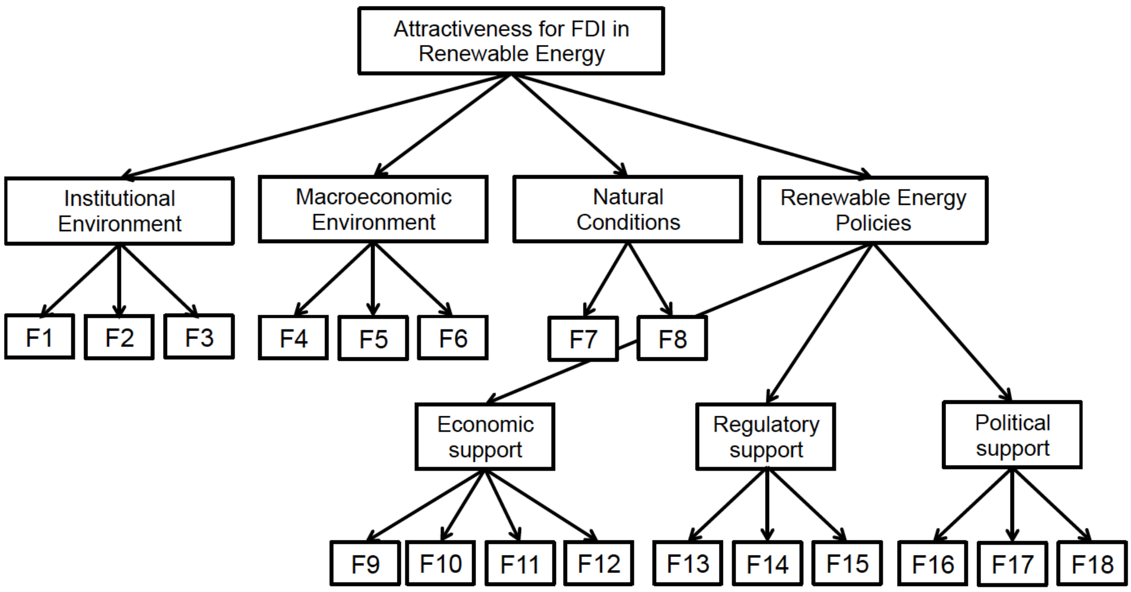
Social acceptance

As expressed in "Not In My Back Yard (NIMBY)" problem occasionally encountered in wind and solar energy projects, social acceptance toward wind and solar energy is important for smooth implementation of wind and solar energy projects. Reiche and Bechberger (2004) state that policy can influence social acceptance by introducing the case in Austria, public awareness is raised through requiring information about the electricity mix in electricity bills. By doing so, some customers might change to other electricity companies if they see that they receive electricity from coal or nuclear power. For foreign investors, social acceptance is something that is hard to see clearly, unless there are projects that have been aborted due to resistance from the local community of the host country (*Company B*).

4.4 Results of the AHP Analysis – Relative Significance of the Determinants

This sub-section presents the results of the AHP analysis that is conducted to clarify the relative importance of the determinants of FDI in renewable energy identified through the literature review and semi-structured interviews.

In order to conduct the AHP analysis, the hierarchy is created with the broad categories, sub-categories, and the determinants that have been clarified through the literature review and the semi-structured interviews with the experts as presented in the previous sub-sections. The top of the hierarchy is the theme of the analysis: “Attractiveness for FDI in Renewable Energy”, and broad categories (institutional environment, macroeconomic environment, natural conditions, and renewable energy policies) come below that. Sub-categories come under the broad category of renewable energy policies in the hierarchy. Lastly, the identified 18 determinants come under them. The hierarchy is structured as presented in the Figure 4.1. Respondents were first asked to evaluate relative importance of four broad categories (institutional environment, macroeconomic environment, natural conditions, and renewable energy policies) by comparing them to one another two at a time with respect to their impact on the theme of the hierarchy: Attractiveness for FDI in Renewable Energy. Then next the sub-categories below the broad categories are evaluated in the same way, and so as the determinants. Based on the evaluation made by the respondents, priority (relative significance) of each determinant is calculated.



F1: Political risk	F10: Auction
F2: Administrative procedure	F11: Tax-incentives
F3: Effective law enforcement	F12: REC&RPS
F4: Exchange rate volatility	F13: Priority access to grid
F5: Access to local finance	F14: Absence of LCR
F6: Labor costs	F15: Technical standards
F7: Natural resources	F16: Renewable target
F8: Access to land	F17: Development plan
F9: Feed-in tariff	F18: Social acceptance

Figure 4.1 Hierarchy structure of the determinants

4.4.1 Relative significance of the broad categories

First, the four broad categories: institutional environment, macroeconomic environment, natural conditions, and renewable energy policies, were evaluated by the experts. The evaluations made by the experts were analyzed using the aforementioned AHP.

Figure 4.2 depicts the result of the analysis. Based on the evaluation made by the experts, renewable energy policies work as the strongest determinants with the weight of 40%. Macroeconomic environment and natural conditions follow renewable energy policies with the weight of 25% and 21% respectively. Institutional environment was evaluated as the least important determinant with the weight of 14%. Consensus ratio shows 68%, which indicates moderately high consensus among the respondents on the evaluation.

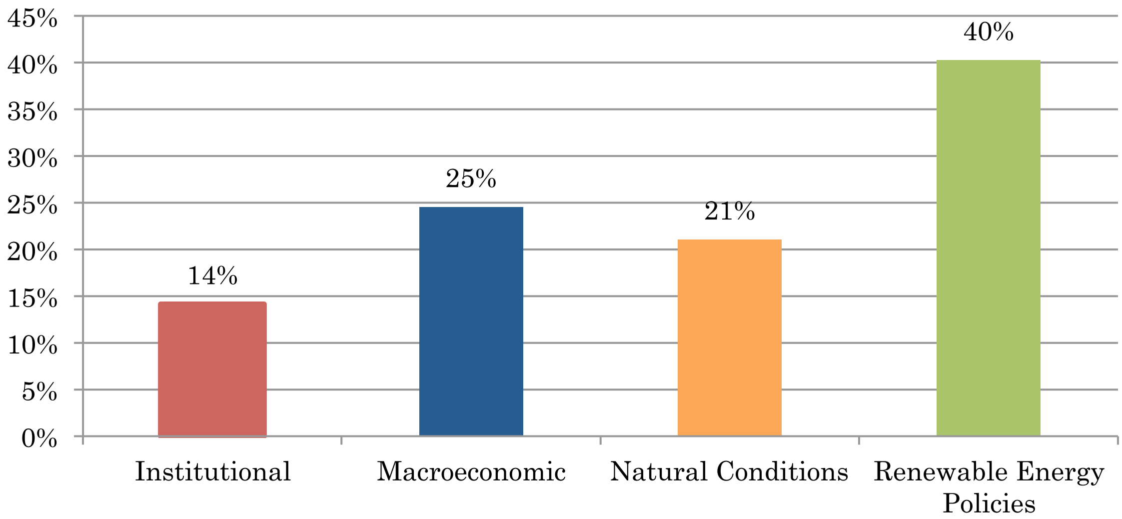


Figure 4.2 Relative significance of the broad categories

4.4.2 Relative significance of the institutional determinants

Next, the relative significance of the institutional determinants, political risk, administrative procedure, and effective law enforcement, is presented in Figure 4.3. Administrative procedure is perceived to have the strongest importance as a location determinant of FDI in renewable energy in developing countries with the weight of 46%. Renewable energy projects require various permits and licenses for the development and operation of the projects, involving various ministries and stakeholders such as local communities. Obtaining permits and licenses could be slow and unclear process especially for some developing countries, which is why transparent and smooth administrative procedure is deemed as a important determinant. Political risk and effective law enforcement follow this with the weight of 30% and 23% respectively. Consensus ratio is moderately high with 66%.

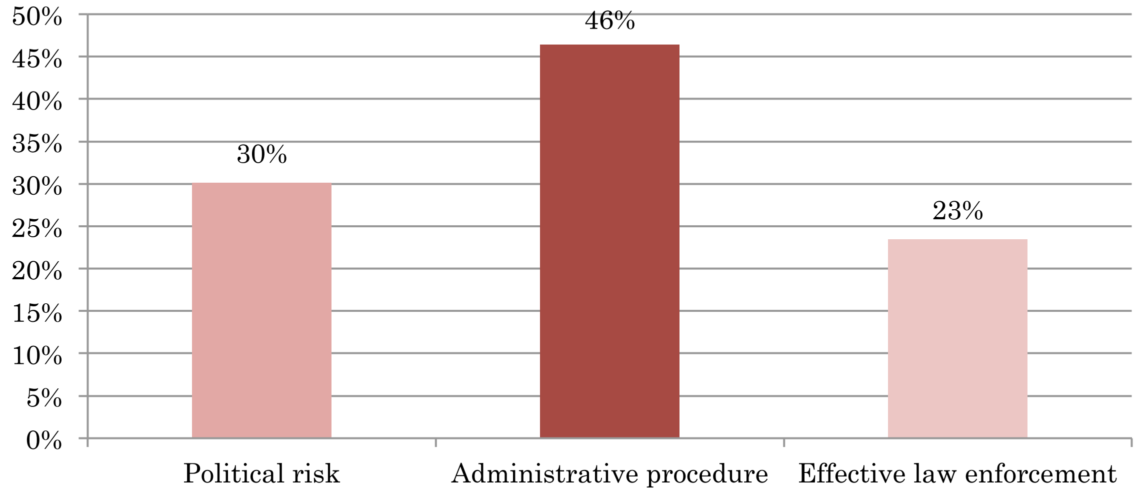


Figure 4.3 Relative significance of the institutional determinants

4.4.3 Relative significance of the macroeconomic determinants

The result of relative significance of the macroeconomic determinants, exchange rate volatility, access to local finance, and labor costs, is presented in Figure 4.4. The experts view exchange rate volatility as the strongest determinant among the macroeconomic determinants, with the weight of 60%. This is because of the long-term payback period of wind and solar energy projects, and the role of renewable energy investment as low-volatility investment in a lot of companies' investment portfolio, as partly explained in sub-section 4.3.2.

Access to local finance and labor costs hold much weaker importance compared to exchange rate volatility with the weight of 26% and 14% respectively. Consensus ratio among the respondents is moderately high with 68%.

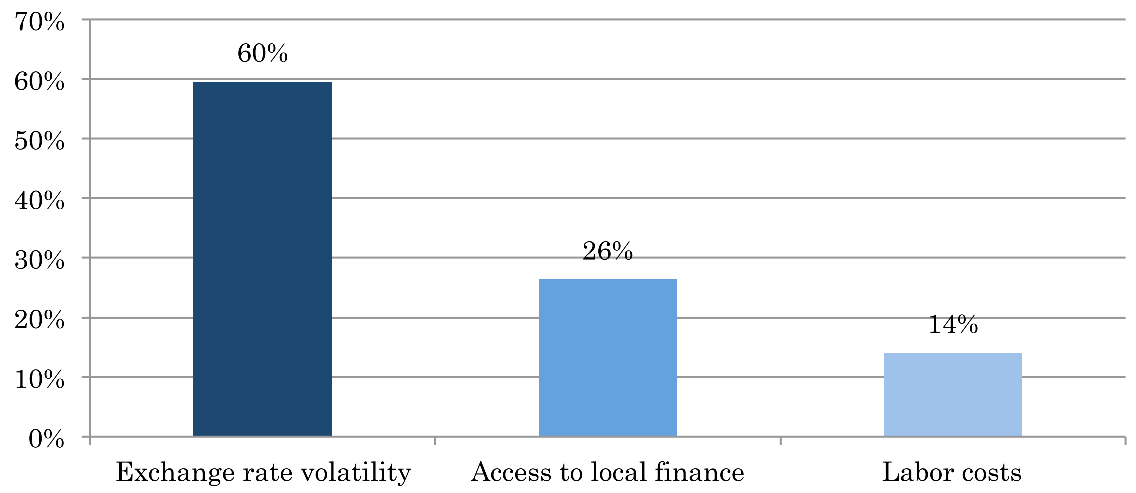


Figure 4.4 Relative significance of the macroeconomic determinants

4.4.4 Relative significance of the natural conditions determinants

Figure 4.5 shows the relative significance of the natural conditions determinants, natural resources and access to land. These determinants both have strong importance with the weight of 42% and 58%. Consensus ratio among the respondents is moderately high with 65%, but the lowest among the all evaluations. This is partly due to differences in experiences regarding land acquisitions for the projects. Depending on the kind of renewable support policies prepared, some developing countries offer support for land acquisition process so that the projects can be smoothly implemented with lower risk of the projects being hampered by land issues. This different view on the importance of access to land was also observed in the semi-structured interviews with the experts.

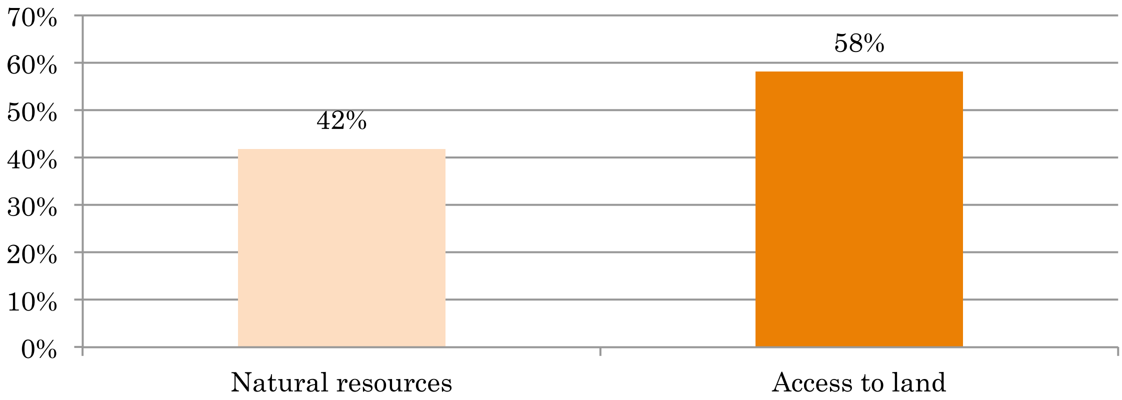


Figure 4.5 Relative significance of the natural conditions determinants

4.4.5 Relative significance of the renewable energy policies

As presented in Figure 4.6, the result of the relative significance of the renewable energy

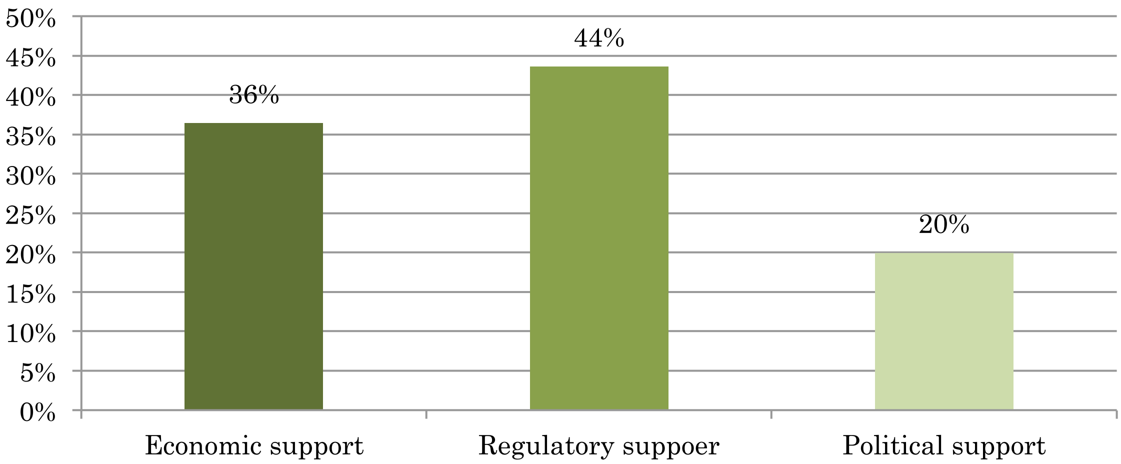


Figure 4.6 Relative significance of the renewable energy policies

policies showed that regulatory support policies and economic support policies both hold strong importance with the weight of 44% and 36% respectively. Political support policies are perceived to have the least important roles with the weight of 20%. Consensus ratio shows 70%, indicating high consensus among the respondents.

4.4.5.1 Relative significance of the economic support policies

Figure 4.7 presents the result of the relative significance of the renewable economic support policies. Feed-in tariff, one of the most common policies deployed in developing countries, is evaluated to have the strongest significance with the weight of 46%. Auction, which has also been increasingly implemented in various developing countries follow this with the weight of 27%. Tax-incentives and REC&RPS hold weaker importance with the weight of 15% and 11% respectively. Consensus ratio among the respondents is high with 70%.

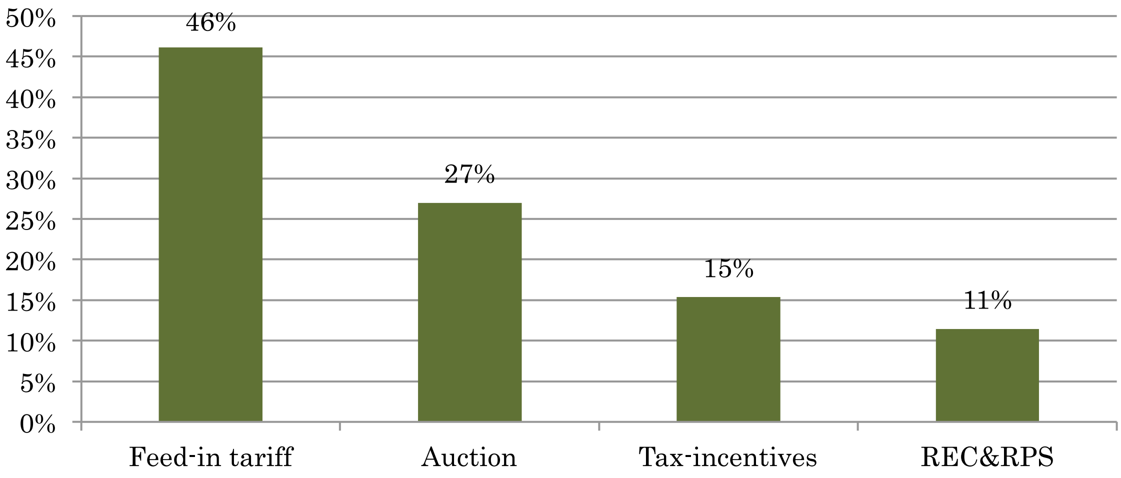


Figure 4.7 Relative significance of the economic support policies

4.4.5.2 Relative significance of the regulatory support policies

The result of relative significance of the renewable regulatory policies, priority access to grid, absence of LCR, and technical standards, shows that priority access to grid is by far the most important determinant among the regulatory support policies with the weight of 63% (Figure 4.8). Local content requirements, which could greatly affect profitability and operational risk of renewable energy projects hold surprisingly weaker importance compared to priority access to grid with the weight of 25%. The could be partly because for small-scale energy projects, the logistics and cost of grid connection can significantly drive up the cost of the projects more than local content requirements do. Although the significance is lower than priority access to grid, when a country has limited technological capacity, the existence of local content requirements

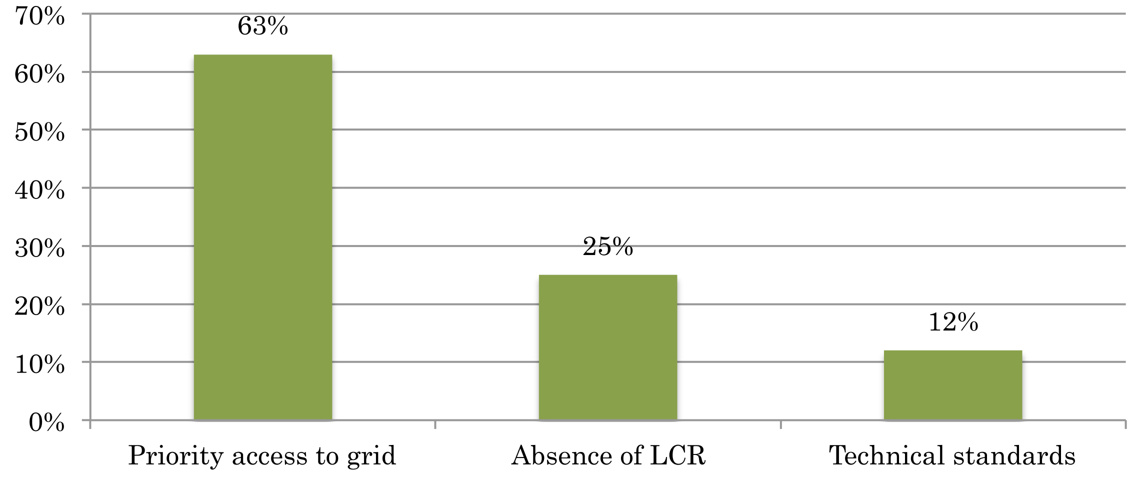


Figure 4.8 Relative significance of the regulatory support policies

greatly reduces the freedom of selection of a reliable supplier, and increases both cost and operational risk of the projects. Consensus ratio among the respondents is very high with 78%

4.4.5.3 Relative significance of the political support policies

Figure 4.9 shows the result of relative significance of the renewable political support policies: renewable energy target, development plan, and social acceptance. Having well-structured renewable energy development plan is perceived to have the strongest importance with the weight of 46%, followed by having national renewable energy target with the weight of 34%. Under the international pressure, a lot of developing counties set high national renewable energy targets. However, those targets are frequently not well linked to known indigenous energy resources, expected costs of development and operation, local training needs, budgetary needs, and actions to achieve the goals, which makes it less reliable than well-structured development plan. Social acceptance surprisingly holds the lowest importance with the weight

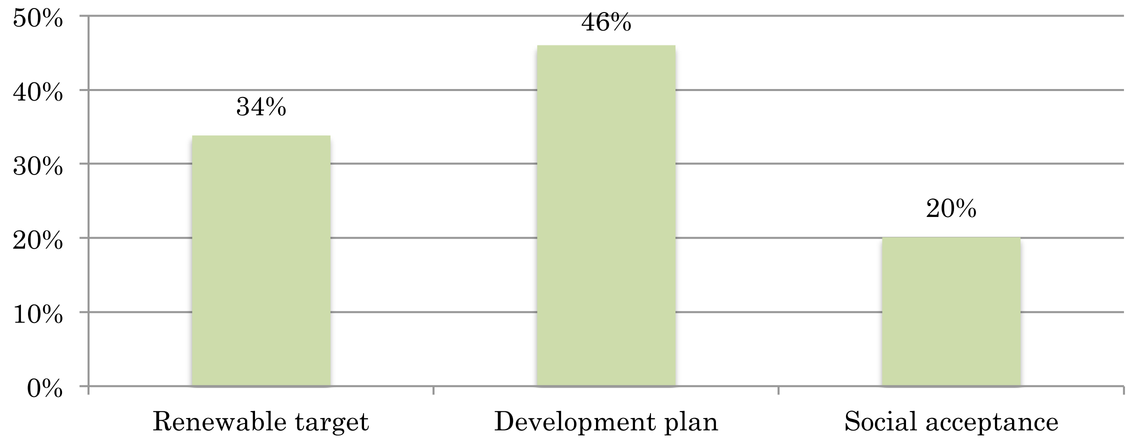


Figure 4.9 Relative significance of the political support policies

of 20%. As expressed in NIMBY problem, in developed countries there are a lot of cases that wind and/or solar projects get hampered because of resistance of local communities. As it was observed in the semi-structured interview, for conducting wind and/or solar projects in developing countries, the objections from local communities are perceived to be less likely to happen compared to projects in developed countries.

4.4.6 Relative significance of the determinants

Finally, the relative significance of each determinant is calculated by multiplying each determinant's weight by that of the weight of the category the determinant belongs to. For example, in the case of political risk, its weight (30%) is multiplied by the weigh of institutional category (14%), which makes the relative significance of political risk as 4% among all the determinants.

Figure 4.10 shows the final results for all of the determinants. Exchange rate volatility holds the highest weight among the determinants with the weight of 15%, followed by access to land (12%), priority access to grid (11%), natural resources (9%), feed-in tariff (7%), and administrative procedure (7%). This final result (Figure 4.10) shows what factors are important for enhancing attractiveness for FDI in renewable energy, and the priorities (relative significance) between the factors.

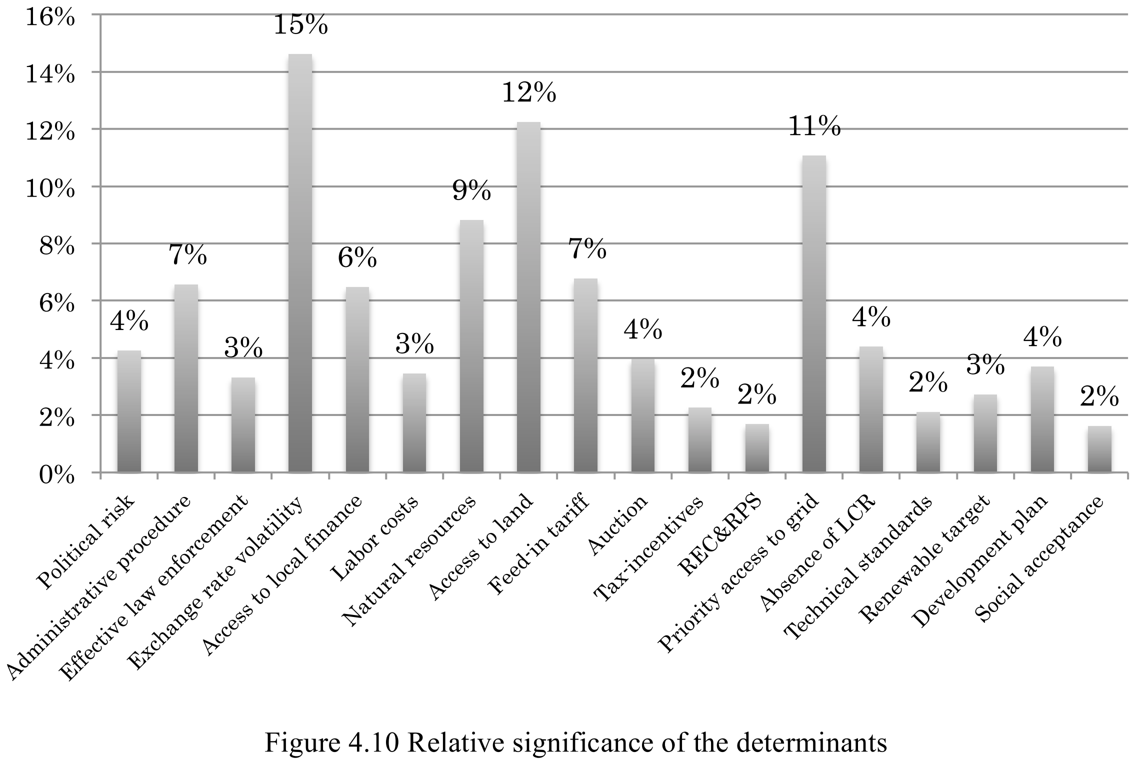


Figure 4.10 Relative significance of the determinants

4.5 Summary of Chapter 4

In order to verify and complement the results of the econometric approach presented in Chapter 3, this chapter presents the results of the study that aims to identify the determinants of FDI in renewable energy, and the relative importance of the determinants based on thorough literature review, semi-structured interviews, and questionnaires conducted with practitioners active in the field of FDI in wind and solar energy in developing countries. Based on the literature review, a total of 24 factors are identified as potential determinants of FDI in renewable energy in developing countries. In order to reflect the opinions of practitioners and verify the importance of the factors identified through the literature review, semi-structured interviews were conducted with experts, and the 24 factors are narrowed down to 18 determinants. These determinants are classified in four broad categories: institutional environment, macroeconomic environment, natural conditions, and renewable energy policies.

Based on the data obtained through questionnaires conducted with 19 experts in the field, the relative significance of the identified determinants was analyzed using AHP. The analysis shows that determinants such as exchange rate volatility, access to land, priority access to grid, natural resources, feed-in tariff, and administrative procedure are perceived to hold strong importance as location determinants of FDI in renewable energy in developing countries.

This mix of qualitative and quantitative approach strengthen the argument made based on the econometric analysis presented in Chapter 3, through showing that renewable energy policies hold equivalent or stronger importance for foreign investors compared to the traditionally argued determinants such as institutional environment and macroeconomic environment. This approach also provides more detail analysis on the effectiveness of each renewable support policy. The results are mostly in line with that of econometric approach, but this study shows that factors that weren't found to be key determinants in econometric approach, such as exchange rate volatility and access to land, are critical determinants in the eyes of experts in the field. The results of this study clarify the relative significance of the determinants, which offers criteria for prioritizing policies and actions that can lead to enhancement of a country's attractiveness for obtaining FDI in renewable energy.

5. Enabling environment for FDI in RE in Developing Countries – Case of Mini-Hydro Energy

Understanding the enabling environment that enables development of renewable energy projects, or barriers and hindrances that impede installation of renewable energy are crucial for further facilitating investment in renewable energy resources worldwide. In the case of FDI in renewable energy sector, as presented in chapter 3 and 4, various renewable energy sector-specific factors act as determinants of FDI in the sector besides other commonly argued determinants of FDI such as macroeconomic environment, institutional environment, and natural resources.

The study presented in previous chapters show that renewable support policies such as feed-in tariff system, priority access to grid, and absence of local content requirements are some of the major factors that have impact on foreign investors' decision-makings. These studies provide valuable information for policy makers for creating an enabling environment that facilitates FDI in renewable energy. However, when looking more carefully into project development of specific renewable energy technologies such as mini-hydro energy, wind energy, and solar energy, there could be other minor technology-specific factors that constitute the enabling environment for attracting FDI. As suggested by Painuly (2001), interaction with practitioners in the field is "very crucial to identification of the barriers as the perception of stakeholders on barriers may reveal the lacunae in existing policies and help in identification of measures to overcome the barriers". Therefore, in order to further identify the required enabling environment, there needs to be more analyses that reflect opinions of practitioners in the field.

Building up on the studies presented in previous chapters, this chapter introduces an assessment guideline of enabling environment for FDI in renewable energy, focusing on one of the renewable energy sources that has high potential in various countries, mini-hydro energy. The assessment guideline has been developed based on the following two steps: 1) implementing mini-hydro energy projects in Japan and conducting participant observation at the project sites, and further interactions with other practitioners; 2) formulating and modifying an assessment guideline by applying to the case of FDI in mini-hydro energy in Indonesia through literature review and field survey, and interviews with key stakeholders.

The proposed guideline for analyzing enabling environment for FDI in mini-hydro energy in developing countries is expected to be the basis of future analyses of other developing countries. In this thesis, mini-hydro energy is defined as hydro energy plants with capacity smaller than 10MW.

In the following sections, first the key factors that constitute enabling environment for mini-hydro energy development in Japan is introduced. The author has been involved in mini-hydro energy project development in Japan, and has conducted participant observation at the project sites, and interactions with other practitioners. The factors that constitute the enabling environment are presented referring to information obtained through the participant observation and literature review. Next, based on the identified key factors and by building upon the preceding studies, an assessment guideline of enabling environment for FDI in mini-hydro energy is proposed and applied to the case of Indonesia, and further modified through the information obtained through the literature review and the field survey. Finally the assessment guideline is reformulated and proposed in the thesis.

5.1 Key Factors Identified Based on Social Implementation in Japan

Since the introduction of feed-in tariff system (FIT), renewable energy development in Japan has been steadily increasing especially for solar energy, and wind energy to lesser extent. Table 1 shows the purchase price for mini-hydro energy and solar energy under the current FIT. The purchase price of FIT is set based on expected cost for development and operation and maintenance of each renewable energy technologies. As it is obvious from Table 5.1, the price for solar energy in 2016 has shown 40% decrease from the initial price set in 2012. However, for mini-hydro energy, the purchase price hasn't been changed since the introduction of FIT. This shows that development of mini-hydro energy in Japan has been slow, and related development and operation and maintenance haven't been lowered enough. In fact, at the end of 2016, 447,949 solar energy projects (10kW≤capacity) have been implemented utilizing the FIT, while only 232 projects have been implemented for mini-hydro energy (Agency for Natural

Table 5.1 Purchase price of energy from mini-hydro energy and solar energy under FIT in Japan

Year	2012	2013	2014	2015	2016
Mini-hydro Energy (200kW≤Capacity<1,000kW)					
Purchase Price	¥29 + tax	¥29 + tax	¥29 + tax	¥29 + tax	¥29 + tax
Duration	20 years	20 years	20 years	20 years	20 years
Mini-hydro Energy (Capacity<200kW)					
Purchase Price	¥34 + tax	¥34 + tax	¥34 + tax	¥34 + tax	¥34 + tax
Duration	20 years	20 years	20 years	20 years	20 years
Solar Energy (10kW≤Capacity)					
Purchase Price	¥40 + tax	¥36 + tax	¥32 + tax	¥29 + tax	¥24 + tax
Duration	20 years	20 years	20 years	20 years	20 years

Resources and Energy, Ministry of Economy, 2017). Based on the assessment of the Ministry of the Environment in 2011, there are approximately 22,428 potential mini-hydro energy project sites in Japan, which hold around 6.25GW generation capacity (Ministry of the Environment, 2011).

5.1.1 Literature Review and Participant Observation

Despite of this great potential of mini-hydro energy in Japan, various barriers and obstacles hinder the development. In order to formulate an assessment guideline of enabling environment for FDI in mini-hydro energy in developing countries, the case of domestic investment in Japan is first investigated through literature review and participant observation, and key factors that constitute the enabling environment for mini-hydro energy projects are presented.

There are studies that investigate barriers and key factors that are important for development of mini-hydro energy in Japan. Itakura (2003) has conducted questionnaires to mini-hydro energy project developers in Japan to clarify the barriers. The paper states that economic aspects such as high initial cost, and regulatory aspects related to access to electricity grid are some of the important barriers to the development of mini-hydro energy in Japan (Itakura, 2003).

Ito (2012) points out the advantages of mini-hydro energy such as high capacity factor (60%~70%), low output fluctuation, and maturity of the technology when compared to solar energy and wind energy. However, he also states that mass production effect doesn't work at high degree for mini-hydro energy technologies, which is keeping the generation cost at high rate, thus requiring further subsidies for initial capital cost to implement mini-hydro energy projects (Ito, 2012).

Nagata and Yanai (2014) conducted a case study of mini-hydro energy project in Gifu prefecture, and examined the relationship with its implementation body and the local community. The study points out that there needs to be proper coordination between the implementation bodies and local communities to formulate common goals and to secure irrigation water, and stresses the importance of making the best use of the community-revitalization potential that mini-hydro energy projects have.

Iida and Kanekiyo (2014) study the potential and barriers of mini-hydro energy implementation in a mountainous area of Kumamoto. They conclude that utilizing irrigation channels is one of the best ways that can control water flow and has high potential in the area, and based on the questionnaires to the local communities they state that safety issues generation systems and the sound that generation systems make need to be well-managed to get acceptance from local communities.

Kobayashi (2010) looks into the barriers to implementations of mini-hydro energy in Japan, and lists up issues related to water rights, especially obtaining permits when using water from irrigation systems and rivers, and access to electricity grid as major barriers.

As can be seen in these preceding studies, there are studies that look into the key factors for the implementation of mini-hydro energy in Japan, but the aspects those study look into are fragmented, and also some of the important factors that are necessary for implementation of mini-hydro energy projects haven't been well examined. Painuly (2001) stresses the importance of combining literature review and interactions with practitioners for identifying key factors for successful implementation of renewable energy projects including mini-hydro energy. Therefore, in order to formulate a comprehensive assessment guideline of enabling environment for mini-hydro energy development in japan building up on the preceding studies, the author has been involved in the implementation of mini-hydro energy projects in Fukuoka prefecture, Japan, and conducted participant observation at the project sites.

The mini-hydro energy projects are conducted as part of the Project Based Research (PBR) of Advanced Integrated Studies in Human Survivability, Kyoto University, which aims at creating

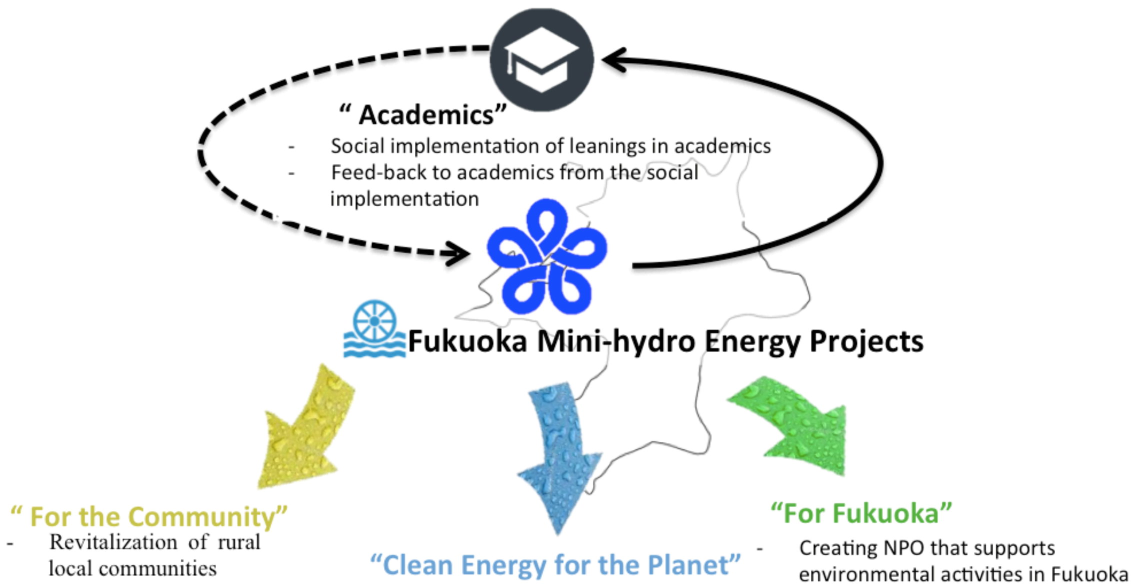


Figure 5.1 Concept of the mini-hydro energy projects of PBR

synergy between project implementation and research activities. The author has been involved in the projects since February 2016, and has been involved in development of 5 mini-hydro energy projects in Fukuoka prefecture. Figure 5.1 represents the concept of the project. Through conducting participant observation being involved in the development of the projects, and further interacting with other practitioners that are active in the field of mini-hydro energy, the author has investigated key factors that constitute enabling environment for mini-hydro energy development in Japan.

5.1.2 Enabling Environment for Mini-hydro Energy Development in Japan

This sub-section presents the key factors that are important for implementing mini-hydro energy projects in Japan, and explains the factors in light of the information obtained through literature review, participant observation, and interactions with other practitioners. The key factors identified in the study are classified into the following 5 categories: renewable support polices, resource and data, permits and licenses, technology and infrastructure, and key stakeholders.

5.1.2.1 Renewable support policies

Renewable energy, including mini-hydro energy, is supported by various support policies. From a theoretical standpoint, those support policies can be justified as a way of correcting negative externalities resulting from the use of fossil fuels and of achieving dynamic efficiency by stimulating technical change (REN 21, 2015). Renewable support policies can be categorized into economic support policies, regulatory support policies, and political support policies.

Economic support policies

The main economic support policies for mini-hydro energy in Japan include feed-in tariff (FIT), and subsidies for conducting feasibility studies. The generation cost of mini-hydro energy could vary depending on geographic topology of project sites, but it is estimated to be around ¥19.1 to ¥20.0 per kWh in Japan (Cost Verification Committee, 2011). This generation cost is higher than that of using fossil fuels, and even other renewable energy sources. Thus, in order to make the project economically feasible, mini-hydro energy projects need to be supported by FIT, which offers a guaranteed price for electricity generated by renewable energy with a purchase obligation by the utilities for a fixed long-time period. In Japan, as presented in Table 1, FIT for mini-hydro energy is fixed for 20 years with purchase price of ¥29 for capacity above 200kW, and ¥34 for capacity below 200kW. Besides FIT, compared to other renewable energy sources such as solar energy, mini-hydro energy projects require long time for the development (2 to 6 years). This is partly because feasibility study usually requires long-term assessment of water flow, ecosystem investigation, and negotiations with landowners. Since the feasibility study requires approximately around 10% to 30% of the total project cost (depending on the size of the project), subsidy for feasibility study is a vital factor that facilitates the implementation of mini-hydro energy projects.

Regulatory support policies

Having access to electricity grid is primary important factor that enables implementations of projects. In Japan, as of July 2017, there are various areas that regulate access to electricity grid due to over capacity and development plan of the areas. Since most of mini-hydro energy projects are implemented with project finance that require guaranteed flow of revenue, if there are any risks in grid connection that affects the future revenue of the project, the project would not be able to obtain finances for the implementation. Thus, condition regarding access to grid in project sites is a vital factor that affects feasibility of the project.

Regulation regarding import tax is another factor that is important especially for mini-hydro energy. Compared to country that also has high potential for hydro-energy such as Germany and Austria, Japan has installed a lot of large-scale hydro-energy plants over 10MW but not a lot of mini-hydro energy plants, as it can partly be seen from Table 5.2. Because Japan lags in the development of mini-hydro energy, related technology such as small-scale generators are still at

Table 5.2 The number of hydro energy plants (above and below 1000kw) installed in Germany, Austria, Sweden, France, Italy, and Japan

	Germany	Austria	Sweden	France	Italy	Japan
Below 1,000kW	7325	2127	1692	1355	1270	547
Above 1,000kW	404	406	383	796	966	1443

*Created by the author based on Kobayashi (2013)

high cost, and take long time from order to delivery. Thus, importing required technologies from technologically matured countries is one of the ways to lower the cost and implement projects smoothly, which calls for lower import tax. In case of Japan, there is no import tax imposed on generators used for mini-hydro energy.

Political support policies

Political support policies refer to renewable energy target and development plan set not just by central, but also by prefectural and local government. For mini-hydro energy project development, project developers need to coordinate with prefectural and local government for obtaining permits for the development and operation of projects. Thus, having high renewable energy target that includes mini-hydro energy, and well-structured development plan would create better enabling environment that would lead to smoother implementation of projects.

5.1.2.2 Resource data

For conducting feasibility studies, and to obtain some permits and licenses such as water rights and constriction rights. A hydro scheme requires both water flow and a drop in height to produce useful power. Therefore, it is indispensable to check the height of the potential project site at early stage of the feasibility study, and to record the river flow for at least one year to design an appropriate mini-hydro energy plant. Especially for conducting river flow analysis, it is mostly the case that nearby dam's water flow data and daily rainfall data are used to estimate flow duration curve of the project site. For this purpose, it is important that there are accurate rainfall data, data of water flow of nearby dams, and regional geological data.

5.1.2.3 Permits and licenses

There are various permits and licenses that are needed for the development and operation of mini-hydro energy. The required permits and licenses depend on the geographical topology of the project site, and design and layout of the project. In general, in the case of Japan, there permits and licenses that need to be obtained under the following laws and acts: River Law, Electric Facilities for Business Use, Natural Parks Law, Natural Conservation Law, Protection and Control of Wild Birds and Mammals and Hunting Management Law, Law for the Protection of Cultural Properties, Land Expropriation Law, the Agricultural Land Act, Forest Law, Act on the Protection of Fishery Resources, and Sabo-ho (Erosion Control Act) etc. For mini-hydro energy project development, it is important to identify what kind of permits and licenses are needed, and who are the stakeholders that project developers need to interact with, which ranges from local government to central government.

5.1.2.4 Technology and infrastructure

Machines and equipment

As mentioned in "regulatory support policies" part, since Japan lags in the development of mini-hydro energy, related technology such as small-scale generators are still at high cost, and take long time from order to delivery. Weather domestic or foreign technologies are used for the project, it is important to check the applicability of the technologies to the project site, trustability of the manufacture, and expected delivery date of the technologies.

Existing facilities

As shown in Figure 5.2, mini-hydro energy can be developed not just in simple rivers, but also using facilities such as irrigation facilities and water supply facilities. Even when mini-hydro energy is developed within the river, it is often the case that utilizing debris-slide protection, and using discharge water from dams make the project cost significantly lower. Thus, existence

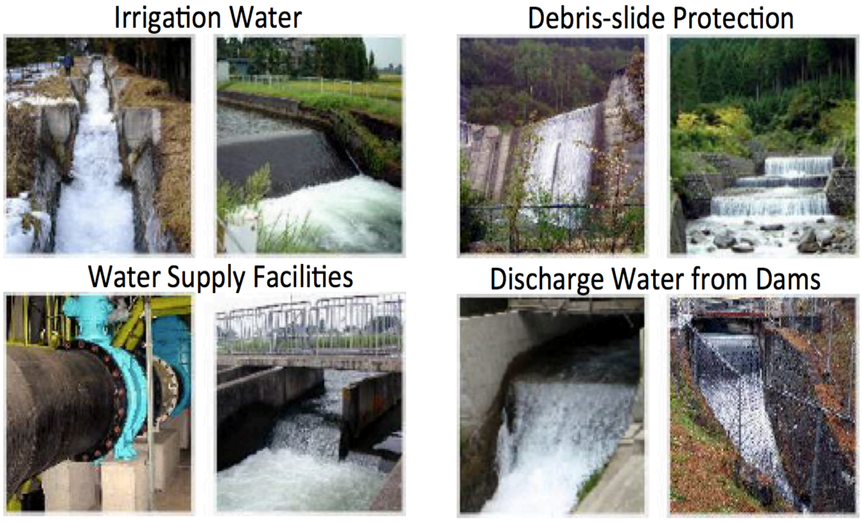


Figure 5.2 Facilities that can be used for mini-hydro energy

and the quality of these facilities are another key factor that is important for the development of mini-hydro energy.

5.1.2.5 Key stakeholders

Community

For mini-hydro energy development, local communities of project sites are very important stakeholders because of the following reasons: 1) it is mostly the case that getting approval from local communities is needed for obtaining permits and licenses including water rights and construction rights; 2) mini-hydro energy plants are considered to last around 60 years or more, thus support and understanding from local communities are important. Therefore, it is important to check the attitudes of the local community of a project site, and examine what kind of local community involvements is possible in the area.

Figure 5.3 depicts potential practices for community involvements created based on the proposed practices of the Ministry of Agriculture, Forestry and Fisheries (2015). The practices can be mainly classified in two groups: local initiative projects, and cooperation projects. Local initiative projects refer to projects that local communities or local cooperatives (where it exists) get involved in the project development by becoming part of the project implementation body. Cooperation projects refer to projects that local communities invest in the project, or solely receive donation from the project developers. Weather which practice work the best for a certain project site depends on the attitude of its local community, in other words, it depends on how much risk the community can take for the development of the project.

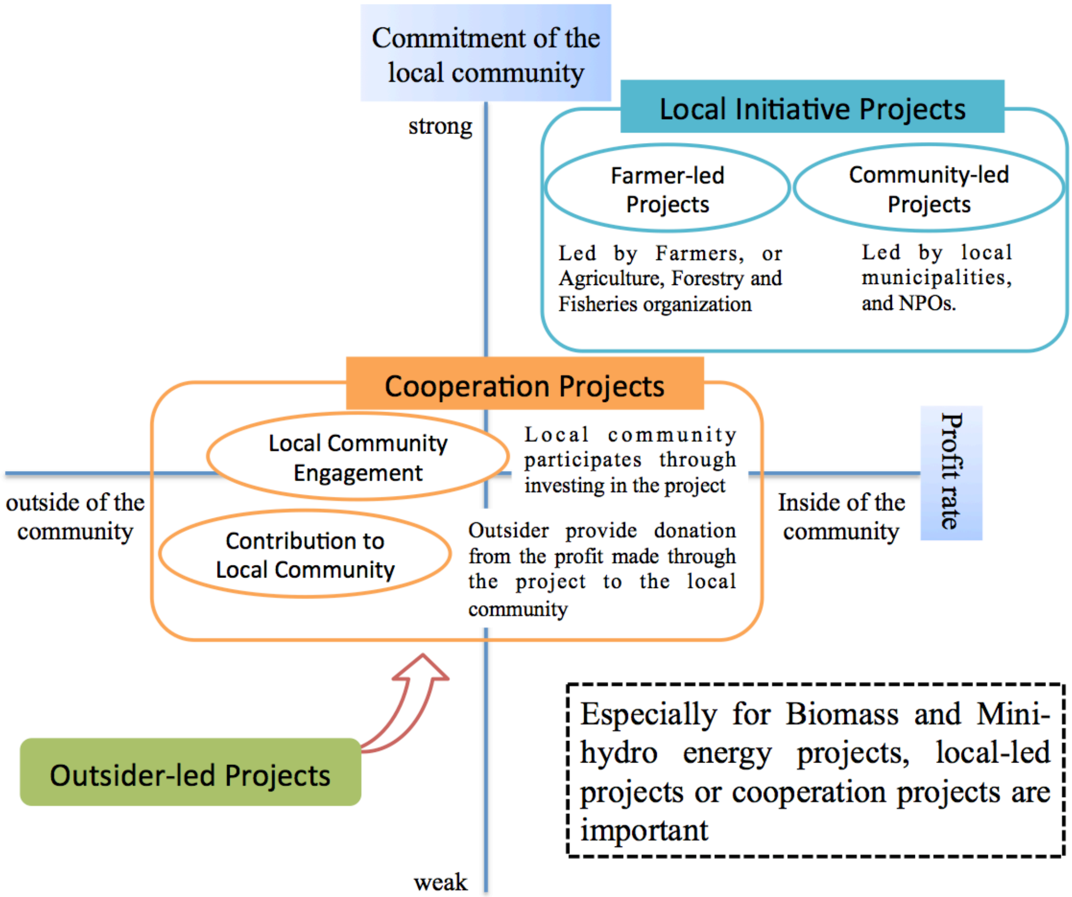


Figure 5.3 Different ways of involvement for local communities in renewable energy projects

*Created by the authors based on Ministry of Agriculture, Forestry and Fisheries (2015)

Fisherman Cooperatives & Agricultural Committees

Fisherman cooperatives and agricultural committees are another important key stakeholders for the development of mini-hydro energy. Not all the rivers have fisherman cooperatives, but it is mostly the case that rivers where fishing is possible have fisherman cooperatives. When conducting a project at those rivers, negotiation with the fisherman cooperative is needed. Fisherman cooperative could demand for maintaining certain water flow rate to conserve the river environment, often at a rate much higher than what is required by the Act on the Protection of Fishery Resources. Fisherman cooperative could also demand for certain “development fee” for using the water that is governed by the cooperative. Without an agreement by fisherman cooperatives, just as like local communities, it is hard to obtain permits and licenses for the development of projects.

Agricultural committees usually exist in every municipality with more than 200ha of agricultural land. For mini-hydro energy projects, penstock and generation facilities could go through or be on agricultural land. In those cases, some agricultural committees require conversion of agricultural land (e.g. to non-agricultural uses) but others don't. These differences will greatly affect the cost and required time for project development, thus the attitude of the agricultural committee of the project site needs to be checked at early stage of the development for appropriate planning and development of the project.

Table 5.3 summarizes the key factors that are identified in this study. It is notable that adding to the commonly observed factors for other types of renewable energy sources including the status of support policies such as feed-in tariff and access to grid, there are factors that are unique to mini-hydro energy development such as the attitudes of local communities, existence and quality of facilities that could be used for the development, and the necessity of negotiation with fisherman cooperatives.

Table 5.3 Summary of the key factors

Renewable Support Policies	
Economic Support Policies	・Structure of economic support policies (Feed-in tariff system, Tendering/Competitive Bidding etc.) ・Existence of other tax incentives
Regulatory Support Policies	・Grid access policy ・Regulations on importing foreign technologies
Political Support Policies	・Development plan for mini-hydro energy
Resource Data	
Data Availability	・Existence and accuracy of data such as daily rainfall data, and regional geological data
Permits and Licenses	
Required Permits and Licenses	・Required permits and licenses for development and operation of a project, especially regarding water use and land use
Technology and Infrastructure	
Machines and Equipment	・Availability of local machines and equipment
Existing Facilities	・The existence of facilities that could be used for mini-hydro energy such as debris-slide protection, irrigation water, water supply facilities, discharge water from dams etc.
Key Stakeholders	
Local Community	・Attitudes of local communities and potential practices for community involvement
Fisherman Cooperatives & Agriculture Committee	・The existence and attitudes of fisherman cooperatives for rivers, and attitudes of agricultural committee

5.2 An Assessment Guideline of Enabling Environment for FDI in Mini-hydro Energy

This section introduces an assessment guideline of enabling environment for FDI in mini-hydro energy, which is developed based on the findings of key factors presented in section 2, and building upon the studies of determinants of FDI in renewable energy presented in Chapter 2 and 3.

In the aforementioned studies, adding to the factors that have been identified in this study including renewable support policies, factors such as currency volatility, access to local finance, labor cost, political risk, effective law enforcement, and administrative procedures were found to be important determinants of FDI in renewable energy in developing countries. By reflecting these findings through combining the factors with the factors identified in this study, an assessment guideline has been formulated. Based on this assessment guideline, the enabling environment for FDI in mini-hydro energy in Indonesia has been investigated through literature review and field survey that includes interviews with key stakeholders. Indonesia is chosen as the case study considering its high potential for mini-hydro energy, and a strong demand for increasing investment in renewable energy. The field survey in Indonesia and interviews were conducted between Oct.15th to Oct.22nd 2017, and assessment of the enabling environment has been performed.

Regarding the field survey, in order to obtain opinions of different stakeholders, interviews were conducted with an international corporation working on the development of mini-hydro energy in Indonesia, a consultancy company, government officials, and a state-owned electricity company. The detail information of the key interviewees is summarized in Table 5.4.

Through conducting the assessment, there were some factors that were identified as key factors that constitute enabling environment for FDI in mini-hydro energy in developing countries.

Table 5.4 Description of the interviewees

Interviewee	Occupation	Interview date
Anonyms	CEO of an international corporation working on the development of mini-hydro energy in Indonesia	October 16th, 2017
Mr. Kiyoshi Izawa	Director of NEWJEC Jakarta office (consultancy company)	October 16th, 2017
Anonyms	Staffs of PLN (state-owned electricity company)	October 17th, 2017
Mr. Faisal Rahadian	An advisor to the Minister of Energy and mineral Resources of Indonesia for Renewable Energy, and the director of Indonesia Mini-hydro Power Association	October 18th, 2017
Mr. Wawan Supriatna	Secretatires of the Directorate General of the Ministry of Energy and Mineral Resources, Directorate General of New, Renewable Energy and Energy Conservation.	October 19th, 2017

Thus, by adding these factors, the assessment guideline has been reformulated.

In the rest of this section, first the general description of mini-hydro energy in Indonesia is provided, and then the results of the assessment of the enabling environment for FDI in mini-hydro energy in Indonesia and final output of the assessment guideline are presented. The results of the enabling environment are presented by examining each factor that constitutes the assessment guideline, based on the literature review and the field survey.

Figure 5.4 shows the final structure of the assessment guideline of enabling environment for FDI in mini-hydro energy in developing countries.

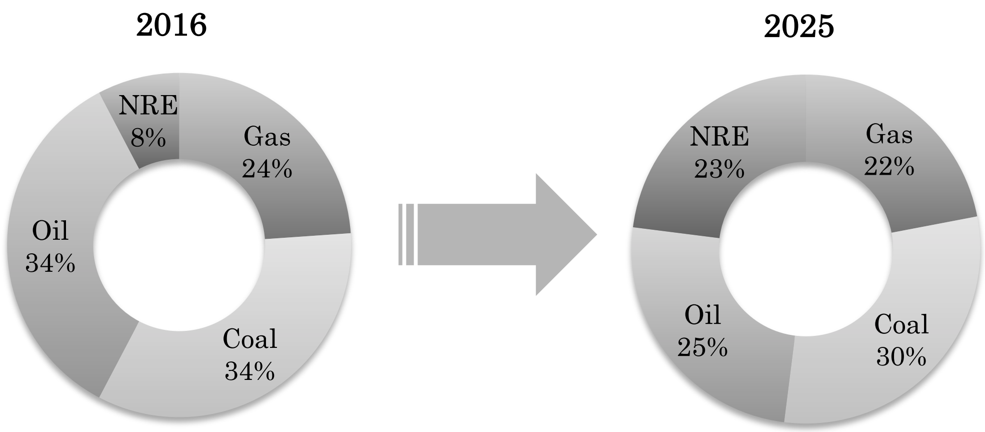
Renewable Support Policies Economic Support Policies Regulatory Support Policies Political Support Policies	・Structure of economic support policies (Feed-in tariff system, Tendering/Competitive Bidding etc.) ・Existence of other tax incentives ・The state of electricity market (openness of the electricity market) ・Grid access policy ・Local content requirement policy ・Development plan for mini-hydro energy
Natural Conditions and Data Resource Availability Data Availability	・Expected annual rainfall, and existence of suitable mountains and rivers ・Existence and accuracy of data such as daily rainfall data, and regional geological data
Macroeconomic Environemt Currency Volatility Access to Local Finance Labor Costs	・Volatility of the exchange rate ・The extent of the development of local financial market for obtaining finance for renewable energy projects ・Expexted costs for construction (cost of civil works and electro-mechanical works) and O&M of the plant
Institutional Environment Political Risk Effective Law Enforcement Administrative Procedures	・The probability of a change of government, and the frequency of violent riots and politically motivated strikes ・Exictence of well-functioning legal system ・Efficiency and transparency of administrative procedures to operate a project
Permits and Licenses Required Permits and Licenses	・Required permits and licenses for development and operation of a project, especially regarding water use and land use
Technology and Infrastructure Machines and Equipment Existing Facilities Grid Infrastrucutre	・Availability of local machines and equipments ・The existence of debris-slide protection, and dams etc., that could be used for a project ・The extent of development of grid infrastructure
Key Stakeholders Local Community Fisherman Cooperatives & Agriculture Committee Central and Local Government	・Attitudes of local communities and common practices for community involvement ・The existence and roles of fishermand cooperatives for rivers, and roles of argicultural cooperatives ・Attitudes and power balanace between central and local government toward project developments

Figure 5.4 An assessment guideline of enabling environment for FDI in mini-hydro energy in developing countries

5.3.1 Energy Conditions in Indonesia

Indonesia is an archipelago rich in renewable energy resources including geothermal, hydro, biomass, solar, and wind energy. Along with a rapidly growing economy, demand of energy continues to expand with an average of 9.1% annual increase. To meet the increasing energy demand, and to progress toward sustainable energy system, Indonesia's fossil fuel-dependent energy sector is undergoing significant changes that are creating both challenges and opportunities.

Figure 5.5 shows the national primary energy target of Indonesia by 2025. In order to meet the rising electricity demand in a sustainable manner, and to lessen the dependency on fossil fuels, the country is working on the development of renewable energy source, aiming to reach 23% of



*NRE refers to New and Renewable Energy sources

Figure 5.5　Indonesia's national primary energy mix target by 2025

*Created by the author based on Ministry of Energy and Mineral Resources of Indonesia (2017)

Table 5.5　Development plan of renewable energy power plant

*Created by the author based on PLN (2017)

Source	Capacity	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Geothermal	MW	305	165	315	186	365	790	345	1015	2510	294	6290
Large-hydro	MW	18	87	323	154	1800	1701	2035	1697	3675	1000	12488
Mini-hydro	MW	68	112	168	198	388	326	178	178	144	81	1964
Solar	MWp	55	12	20	–	–	–	–	–	–	–	87
Wind	MW	–	–	235	170	60	–	–	–	–	–	465
Biomass/Waste	MW	186	78	225	10	11	6	10	10	–	–	536
Marine	MW	–	–	–	–	–	–	–	–	–	–	–
Bio-fuel	Thousand kl	780	1129	809	661	563	519	519	525	531	536	6572
Total	MW	632	454	1286	718	2624	2822	2567	2752	6329	1375	21560

the national primary energy mix by 2025. Renewable energy is also deemed to serve as great power source for providing electricity for people without access to electricity. Among the various renewable energy sources, geothermal and mini-hydro especially have high potential in the country. According to the long-term Energy Development Plan (RUPTL) 2017-2026, which is developed by the state-owned electricity company Perusahaan Listrik Negara (PLN), the country aims to develop mini-hydro energy largely together with geothermal energy (Table 5.5). The state-owned electricity company PLN, which covers around three-fourth of electricity generation and controls the entire transmission and distribution system, dominates Indonesia's electricity market. However, due to its financial condition, PLN can hardly meet the rising electricity demand on its own, which calls for other investment channels including private investors. Table 5.6 shows that around 55% of the future development of power plants is expected to come from independent power producer (IPP). Especially for the introduction of renewable energy technologies including mini-hydro energy, the door is opened for FDI, which is expected to bridge the financial gap needed for the additional investment, and to progress the capacity development of Indonesia's electricity sector (Personal interview, Oct. 19th, 2017). There are indeed a lot of demands in local companies to formulate joint ventures for the development of mini-hydro energy with foreign investors (Personal interview, Oct. 16th, 2017). Including the international corporation interviewed during the field survey, growing number of foreign investors are entering the Indonesian market.

In the following sub-section, the results of the assessment of the enabling environment for FDI in mini-hydro energy in Indonesia are presented, by explaining each aspect that constitutes the proposed assessment guideline (Figure 5.4).

Table 5.6 Total Additional Power Plants Needed in Indonesia by Owner

*Created by the author based on PLN (2017)

Owner	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
PLN	1,332	4,451	3,773	1,502	2,943	1,715	1,904	1,527	1,787	60	20,983
IPP	1,366	1,506	14,839	5,000	4,390	4,373	2,673	2,595	2,290	2,975	42,061
Unallocated	–	–	–	81	581	1,773	971	3,170	7,228	1,025	14,829

Unit: MW

5.3.2 Enabling Environment for FDI in Mini-hydro energy in Indonesia

The enabling environment for FDI in mini-hydro energy in Indonesia is examined for each aspect presented in the assessment guideline (Figure 5.4), which are: renewable support policies, natural conditions and data, macroeconomic environment, institutional environment, permits and licenses, technology and infrastructure, and key stakeholders.

5.3.2.1 Renewable support policies

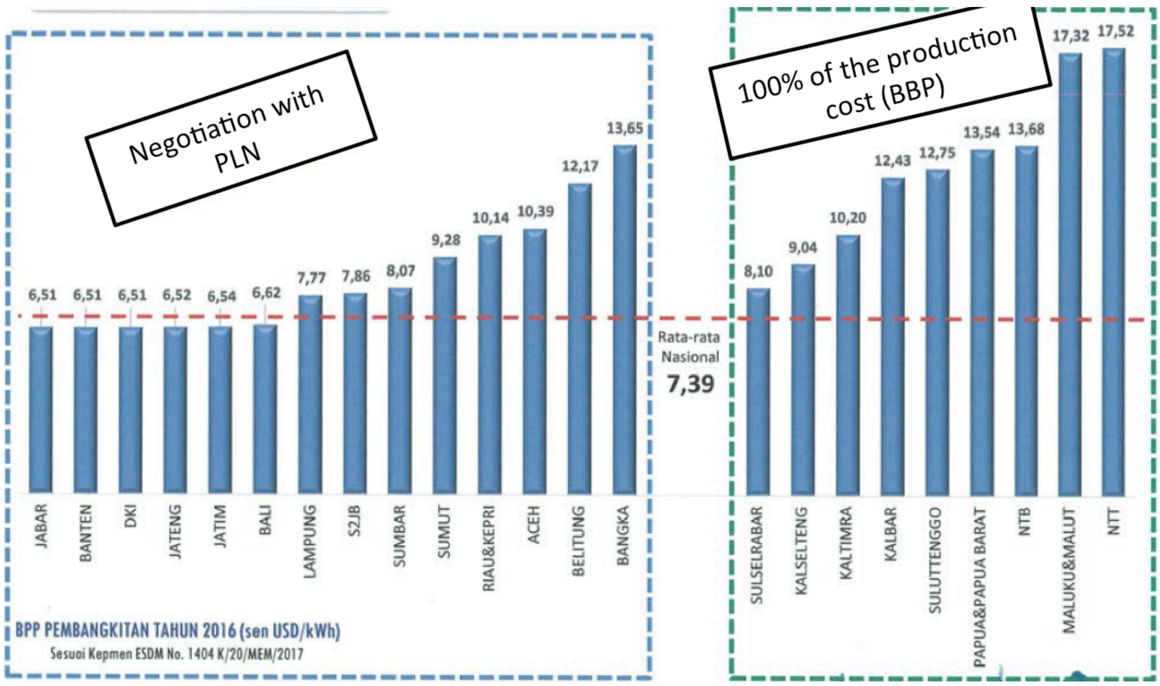
Indonesian government has laid out various support policies for the development of mini-hydro energy, including economic support policies such as FIT to enhance the economic feasibility, and regulatory support policies focusing on creating a smooth and transparent process for obtaining permits and licenses for the development.

Economic support policies

The main economic support policies in Indonesia include FIT. The initial FIT system was introduced for mini-hydro energy in 2002. This first FIT imposed PLN to purchase electricity at 80% of regional production costs of electricity for middle-voltage, and 60% for low-voltage connection from mini-hydro energy. This policy was modified in 2006 to include larger mini-hydropower projects (10 MW), and then another revision was made in 2009 to set more attractive tariff. However, there were several challenges with this first wave of FIT scheme. First, since the energy production was largely subsidized by the government at that time, the utility company was reluctant to the use of renewable energy. Next, the FIT scheme didn't come with guaranteed long-term contracts, and there was no obligation to accept the contract for PLN (Hasan and Wahjosudibjo, 2014). In 2011 and 2012, FIT policy underwent major modifications, which imposed electricity utilities to purchase renewable energy electricity at a fixed tariff. Especially for Indonesia, where electricity sector is dominated by PLN, FIT policy contributes to reducing negotiation time between IPP and PLN regarding the power purchase agreement, including setting the purchase price.

In 2017, there was another revision made for FIT policy, which lowered tariffs paid to IPP (Regulation 12/2017 on the Use of Renewable Energy for the Provision of Electricity). Figure 5.6 shows the purchase price of electricity from mini-hydro energy under the new FIT policy. In this scheme, for the regions with production cost (BBP) for electricity lower than that of the national average, which is determined by PLN and the MEMR, the purchase price will be determined after negation with PLN. For other regions that have higher production cost, 100% of the BBP of the region will be the purchase price.

This new FIT policy was introduced partly because PLN has been reluctant to purchase electricity from renewable energy producers, arguing that the FIT under the old regime were too high and claiming that it is difficult to obtain subsidies from the State Budget. Thus, the lower FIT levels provided in the new regulation is expected to facilitate power purchase agreement



*The blue bars depict the production cost (BBP) for different region.

Figure 5.6 Indonesia's FIT purchase price for mini-hydro energy in different region

*Created based on Ministry of Energy and Mineral Resources on Indonesia (2017)

(PPA) between PLN and IPP.

Other notable aspects of the new FIT policy are that it sets plant factor for mini-hydro energy, which require minimum power generation efficiency of 60%. IPPs also have to make agreement on guaranteed amount of electricity production with PLN, which imposes an IPP to pay penalty fee when the IPP fails to provide the guaranteed amount. Adding to this, the new policy does not follow common practice of FIT policy, which is referred as take and pay, meaning tariff is only paid for the actual electricity received by a purchasing electricity company. Instead, the policy adopts take or pay, in which PLN will pay for all of the electricity generated, even when the electricity can't be received by PLN for some reasons. These changes increase the importance of feasibility study to design a power plant that operates properly to generate expected amount of electricity.

Other important economic support policies for foreign investors include the low income tax (10%) on the dividends of investment for mini-hydro energy.

Regulatory support policies

In order to sell the electricity generated by mini-hydro energy to PLN under the FIT scheme, it is required to pay for the necessary grid construction to connect the power plant to the main grid. Therefore, the distance between the power plant and the main grid can greatly impact the cost competitiveness of a project.

Regulation regarding import tax is another key aspect. In case of Indonesia, import tax is not imposed on technologies and equipment that are not available in Indonesia. However, as it is noted in the latter part (Technology and Infrastructure), some stakeholders assert that Indonesia lacks various technologies and equipment required for the development of mini-hydro energy, but others assert the opposite. This makes it hard to foresee whether this regulation on import tax can be applied to certain technologies that developers would like to use for projects.

Local content requirement, which is set at various developing courtiers, could also be a significant cost driver for mini-hydro energy projects. In case of Indonesia, there is no local content requirement set for mini-hydro energy.

Political support policies

Political support policies, which include renewable energy target and development plan, are important market signals for foreign investors. In Indonesia, as shown in Figure 5.5, the government sets high renewable energy target of 23% by 2025. As presented in Table 5.5, there is also a development plan for mini-hydro energy for the next 10 years, which is announced by PLN every year in RUPTL. In the development plan, mini-hydro energy is deemed as one of the most important renewable energy recourses, which is a great signal that calls for investments from foreign investors.

5.3.2.2 Natural conditions and data

Resource availability

Indonesia has a tropical climate, with high humidity and high temperatures. There are two seasons: a rainy season from November to March and a hot, drier season from April to October. Average yearly rainfall in Indonesia is around 2,700 mm. In lowland areas it ranges from 1,300 to 3,200 mm, while in the mountains it can reach as much as 6,100 mm (United Nations Industrial Development Organization, 2016). Rivers are found in every part of the islands and play an important role in irrigation and transportation. Major rivers can be found on Kalimantan, Java, Papua, and Sumatra. The country’s longest river, the Kapuas (1,143 km), is on Kalimantan. Southern Kalimantan is crisscrossed with a network of hundreds of smaller rivers. According to the estimation of United Nations Industrial Development Organization, Indonesia has a substantial potential of 770 MW for mini-hydro energy, of which only around 70% (229MW) has been utilized (United Nations Industrial Development Organization, 2016).

Data availability

Basic data that are important for conducting project assessment includes hydro-meteorological, geological, and topographical data. These data are important for conducing a water flow analysis, which is indispensable for designing a proper power plant, and to obtain some permits and licenses. The most widely-used method used is a flow duration curve (ex. Figure 5.7), which assesses the hydropower potential of a stream. In case of Indonesia, these hydro-meteorological, geological, and topographical data are often missing or difficult to obtain, especially for remote regions (Personal interview, Oct. 16th, 2017).

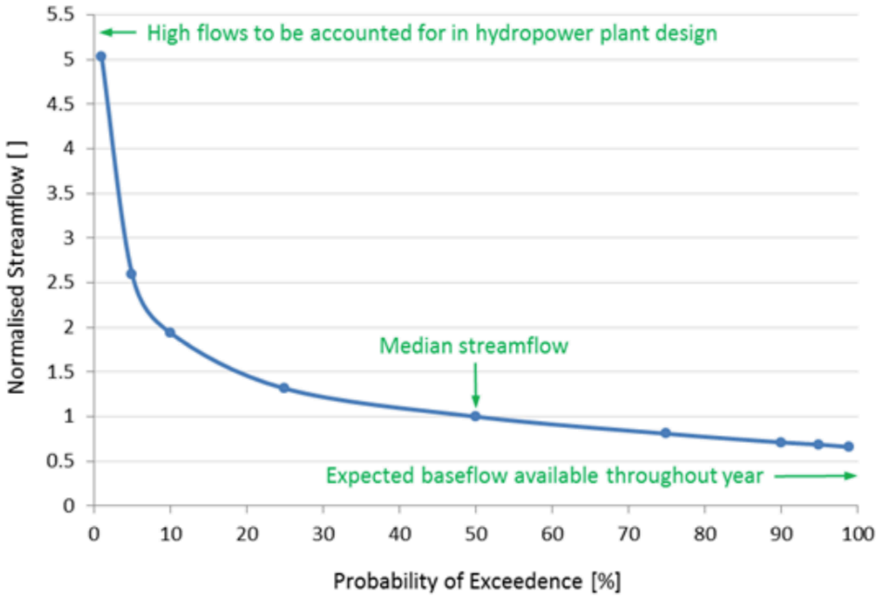


Figure 5.7 An example of a flow duration curve

5.3.2.3 Macroeconomic environment

Currency volatility

The long-term payback period of mini-hydro energy projects makes currency volatility a factor that negatively affects foreign investors' decisions especially for risk-averse investors.

In case of Indonesia, the currency chart (Figure 5.8) of US Dollar to Indonesian Rupiah shows that its currency has been relatively stable for these half a decade. According to Edwards and Sahminan (2008), Bank Indonesia has been showing an inclination to intervene to prevent sharp exchange rate movements in both directions, and there are some signs that Bank Indoensia has been deliberately buying foreign exchange in the market over the longer term to maintain a low, stable rupiah for the benefit of exporters.

Figure 5.8 Currency chart of US Dollar to Indonesian Rupiah

Source: XE Currency Charts (2017)

Access to local finance

Developed financial markets may make financing short- and long-term transactions easier for foreign firms, which helps foreign firms to reduce the exposure to the exchange rate risk. However, access to local finance for renewable energy still remains a challenge in Indonesia. Despite various policies and instruments that support renewable energy investment, financial institutions perceive renewable energy project as a risky investment and are still reluctant to lend money. In some cases, bank is also reluctant to lend unless the investor has a strong financial guarantee by the company's main group or parent companies (Personal interview, Oct. 17th, 2017). In general, local banks are hesitant to provide project finance, but lend corporate finance instead, which limits the number of projects that reaches financial closure. According to the study of WWF, increasing number of Indonesian banks have been involving in co-financing mini-hydro energy project with its foreign partner in recent years (World Wide Fund for Nature, 2014).

Labor costs

Labor costs are important element for mini-hydro energy, which consists of 20% to 50% construction cost, and also continuous O&M costs (Personal interview, Oct. 16th, 2017). Figure 5.9 depicts trends in averages wages and labor productivity in Indonesia by economic sector in 2015. Electricity, gas and water sector is in the third position in terms of the average wage, with high labor productivity. Construction sector has lower average wage, and lower labor productivity. Hydro energy is one of the most matured sector within renewable energy in Indonesia, thus accessing skilled workers are relatively easy (Personal interview, Oct. 16th, 2017).

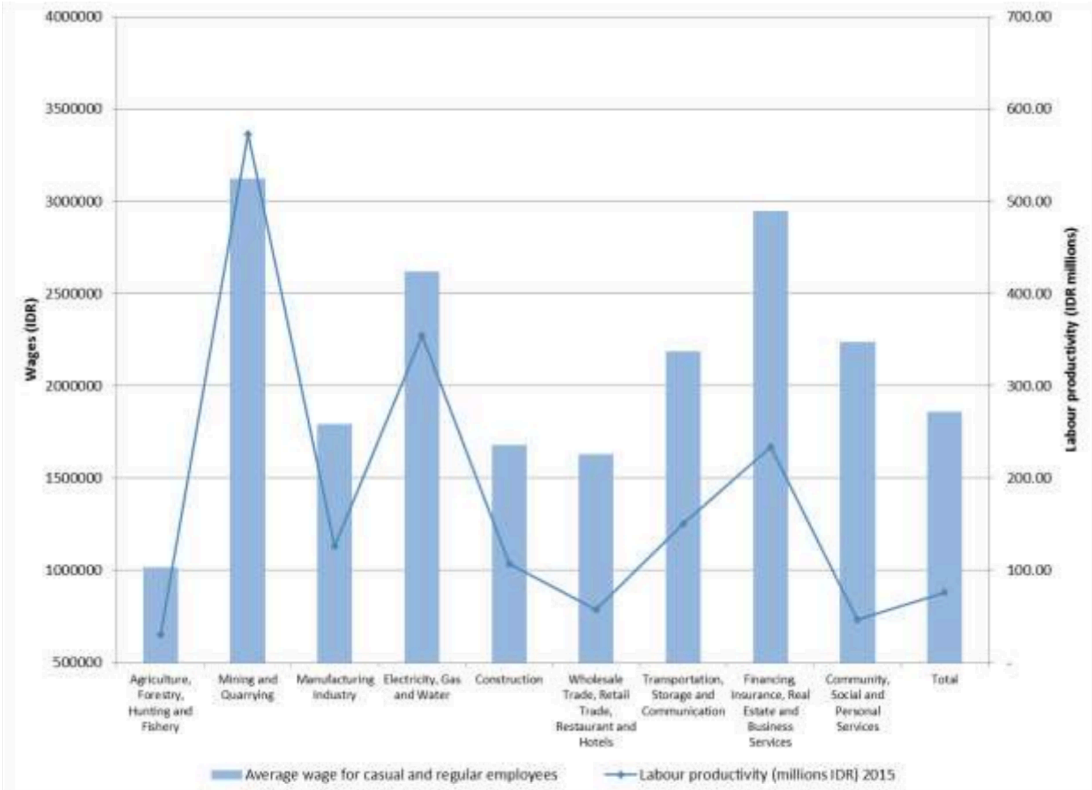


Figure 5.9 Average wages and labor productivity by economic sector in 2015

Source: Allen (2016)

5.3.2.4 Institutional environment

Political risk

Politically, Indonesia is in transitional democracy, since the transition to democracy has began only after 1998, when General Suharto's thirty years of authoritative governance was toppled. Since then, free, peaceful and direct presidential elections have been held successfully, and Indonesia has been transitioning towards democracy with few setbacks (Bunte and Ufen, 2008). However, the study by Voelker et al. investigates political risk perception in Indonesian power projects, and identify that the political risk perception for Indonesian power projects is still relatively high, due to its legal and regulatory risk and breach of contract risk (Volker et al., 2008).

Effective law enforcement

According to the assessment conducted by UNDP, law enforcement of natural resource-related issues has not effectively served but instead, ineffective law enforcement enables the continuation of illegal activities such as illegal logging, mining and plantation activities without appropriate permits (UNDP, 2012).

The heritage foundation assesses judicial effectiveness in Indonesia, and rates the effectiveness relatively low around 40 points, which indicates that the court system is inefficient and subject to delays, and the judiciary may be influenced by other branches of government (The Heritage Foundation, 2017).

Administrative procedures

After General Suharto's thirty years of authoritative governance was toppled, the Indonesia has experienced a drastic changes. The most notable change is that governance system shifted from centralized to decentralized system. The process of decentralization and the expansion of regional autonomy have given regencies and municipalities real power to run their territory in self-governance mode (Tamara, 2009). However, this has also brought some challenges for smooth implementation of mini-hydro energy projects. As it will be further elaborated in "Permits and licenses" part, there are in general around 14 permits and licenses that are needed for the development of mini-hydro energy in Indonesia, and a lot of these have to come from local governments. Based on the survey conducted by Marquarat (2016), the expansion of regional autonomy seems to have had a rather negative impact on renewable energy development in Indonesia, partly because some of the local governments lack the capacity for and a general understanding of promoting renewable energy. This negative effect of the expansion of regional autonomy could be deemed as "cost of decentralization" (Personal interview, Oct. 18th, 2017).

5.3.2.5 Permits and licenses

Required permits and licenses

According to Yuliani (2016), there are there are "at least 14 kinds of permits and licenses (and other permit-like processes) that have to be obtained" before a developer can start the construction of a mini-hydro energy plant, among which "four come from central government, one from provincial government, and nine from regency government. There are also some associated recommendations from related bodies that are a must-have requirement before a permit can be issued" (including community approval).

The problem is that the costs that are required for obtaining the permits and licenses are not stated clearly in general. Sometimes project developers need to go through negotiations, which can lead to unexpectedly high costs (Personal interview, Oct. 16th, 2017). Another issue is that policies regarding river usage permits are not unified among local governments, and also provincial governments and central government (Personal interview, Oct. 17th, 2017).

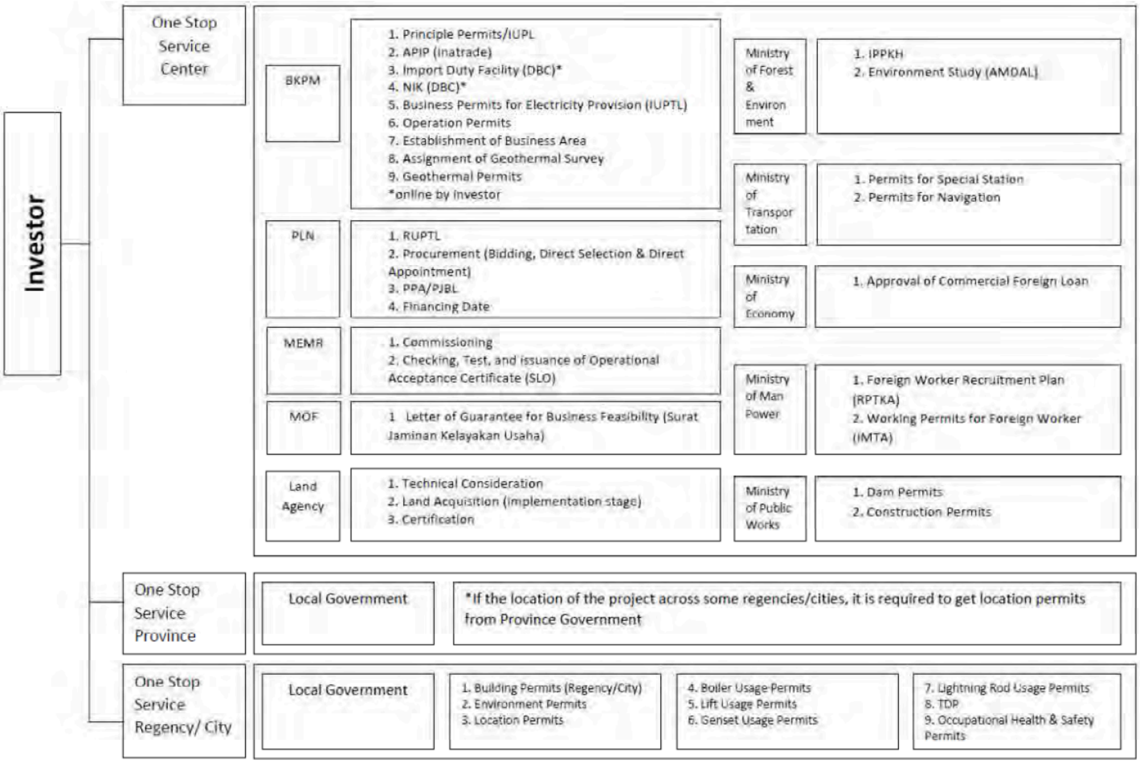


Figure 5.10 The structure of one stop service provided by BKPM

Source: Koei (2015)

Reflecting on the complains from the investors, and in order to facilitate smooth implementation of mini-hydro energy projects, Indonesian government has created one-stop agency called PTSP (Pelayanan Terpadu Satu Pintu) PUSAT in Badan Koordinasi Penanaman Modal (BKPM) in early 2015. BKPM is Indonesian Government's investment service agency. Figure 5.10 depicts the structure of the one stop service provided by BKPM. One stop service is provided at province and regency level, simplifying the tiring process needed for obtaining the required permits and licenses. Although challenges remain, this one stop service provided by BKPM has improved Indonesia's enabling environment for foreign investors (Personal interview, Oct. 16th, 2017).

5.3.2.6 Technology and infrastructure

Machines and equipment

Regarding the machines and equipment needed for mini-hydro energy projects, local capability for the design and manufacturing is limited and is mostly concentrated on Java with rated turbine capacity available being below 1MW (Personal interview, Oct. 17th, 2017). Although there are tax exemptions for machines and equipment that are hardly available in Indonesia, imported equipment can be expensive and spare parts can be difficult to obtain (Personal interview, Oct. 16th, 2017). Furthermore, a challenge that needs to be addressed is the absence of mechanisms such as product liability, quality assurance and technical control institution that would warrant the quality of mini-hydro energy equipment imported or manufactured locally.

Existing facilities

When developing mini-hydro energy, utilizing debris-slide protection, irrigation facilities, and using discharge water from dams make the project cost significantly lower. Based on the eyes of practitioners in the field, there are a lot of potential project sites that can utilize these facilities, and there are request from local companies to create joint ventures with foreign companies to bridge the financial and technological gaps (Personal interview, Oct. 16th, 2017). Irrigation facilities, which usually allows for small-scale mini-hydro energy below 1MW, are mostly utilized by local cooperatives (Personal interview, Oct. 17th, 2017).

Grid infrastructure

If grid infrastructure is not well-developed, then it could decrease the project feasibility in a couple of ways including: cost for connecting to the grid, and decreased return on generated electricity through electricity losses. Electricity grid is more developed in the main islands, but in remote islands the development level is much lower. Figure 5.11 shows the electrification ratio of each region of Indonesia. Indonesia calculates electrification ratio based on a definition called "village electrification ratio", which counts a village has gained access to electricity when at least one household in the village gain access. Thus, the actual household electrification rate in Indonesia is lower than the announced 91.16%, which indicates that connecting to grid

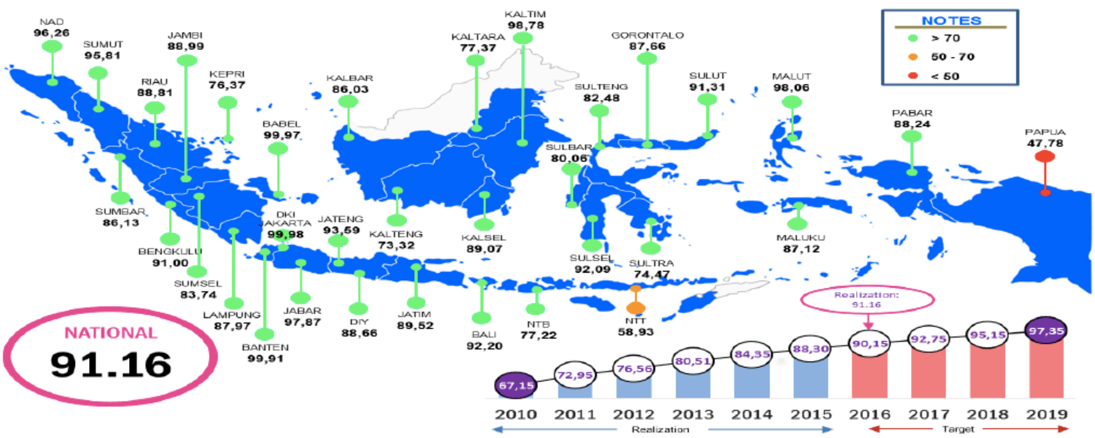


Figure 5.11 Electrification rate in Indonesia by region in 2016

Source: Ministry of Energy and Mineral Resources of Indonesia (2017) infrastructure in rural and remote areas could increase the cost of a project significantly. Regarding electricity losses, electric power transmission and distribution losses assessed by IEA reveals that the loss (% of output) in Indonesia is around 9%, which is relatively low rate for developing countries, making it about the same as that of Canada (The World Bank Data, 2017).

5.3.2.2 Key stakeholders

Local communities

Since the reformation after 1998, Indonesia's governance system is more decentralized, public policy is more bottom-up and participatory, and there is more freedom of speech among the people. Yuliani (2016) asserts that "this new condition in a community sometimes brings problems for the development of infrastructure, especially when there is no sufficient preparation for the community to accept new things, such as renewable energy technologies".

For the development of mini-hydro energy in Indonesia, there's a need to obtain "disturbance permit" from the local community of the project site. In order to get permission of a local community, there are points that need to be checked: water use issue, land issue, and a way for community involvement. When developing mini-hydro energy, community conflicts usually occur concerning water for irrigation, which requires good communication with relevant stakeholders to solve the conflicts. Land issue is another important point since standard price for land is often unclear, especially in remote villages. For foreign investors, price of land could skyrocket, thus partnering up with local stakeholders are one of the important ways to smoothly conduct land acquisition. Some of the foreign companies developing mini-hydro energy offer price four times higher than average price for land (Personal interview, Oct. 16th, 2017).

Some of the common practices for community involvement include: offering certain amount of donation to the community, and allocating some of the construction and O&M jobs to the community.

Fisherman cooperatives and agricultural committee

In some of the developed countries including Japan, the fisherman cooperative in the project site could demand for maintaining certain water flow rate to conserve the river environment, often at a rate much higher than what is required by the government law. In case of Indonesia, there are not many cases where a fisherman cooperative becomes an important stakeholder for the development of mini-hydro energy (Personal interview, Oct. 18th, 2017). However, it is important to check if there are any commercial fishing within the project site, and fishing points after the downstream of the project site and maintain good communication with affected stakeholders if there are any.

With increasing population in Indonesia, the need for land in non-agricultural sectors such as housing, shops, industrial, transportation to be increased, resulting in a large amount of agricultural land conversion. The Indonesian government has been trying to reduce the rate of conversion of agricultural land through enacting some regulations on the protection of agricultural land as well as rules on the conversion of agricultural land into non-agricultural land. There are a lot of cases where a powerhouse of a mini-hydro energy power plant is built on agricultural land close to river. However, there haven't been any large issues reported concerning agricultural land conversion for mini-hydro energy development (Personal interview, Oct. 18th, 2017).

Central and local government

As discussed in "Institutional environment" and "Permits and licenses" parts, there are differences in attitudes and understanding toward mini-hydro energy development between central and local governments, and between one locality and another. One particular issue observed in a lot of cases is regarding river usage permits, which there are confusion among different government bodies for the authority over rivers (Personal interview, Oct. 16th, 2017). Yuliani (2016) reports a case of a mini-hydro energy project of 600 kW in a region of Central Java Province. The construction of the project is already done, but the power plant is not operating because the PPA from PLN has not been obtained yet. The issue is complicated that PLN can't issue the PPA because a permit for water use has not been issued, which needs to be obtained from government. In the beginning local government was deemed to have responsibility for issuing the permit, but it was found out that the central government also holds responsibility to issue the permit for some area of the river in the project site. However, even after the issue became clear, central government has not issued the permits without any clear explanation. The creation of one-stop agency in BKPM has been improving these issues, but it is worth noting that this lack of understanding in some government bodies and differences in attitudes toward mini-hydro energy development could be a time-consuming problem in some cases (Personal interview, Oct. 16th, 2017).

5.3 Summary of Chapter 5

In this chapter, an assessment guideline of enabling environment for FDI in mini-hydro energy in developing countries is developed through following two steps: 1) identifying key factors that constitute enabling environment for mini-hydro energy projects through social implementation of mini-hydro energy projects in Japan and conducting participant observation at the project sites; 2) formulating and modifying an assessment guideline by applying to the case of FDI in mini-hydro energy in Indonesia through literature review and field survey.

Assessment of Indonesia's enabling environment using the proposed guideline revealed several important points to be considered. Although there are a lot of untouched potential sites for the development of mini-hydro energy, it is not easy to find a site with commercially viable conditions. First, the purchase price under the newly revised FIT is much lower than that of Japan: highest purchase price being17.52¢/kwh in the NTT region. Next, considering that grid infrastructure is not well developed in regions with high FIT purchase price, there could be extra cost for a project in a region with poor grid infrastructure, or in a remote area far from grid infrastructure. There are also risks stemming from discrepancies and lack of understanding in some government bodies especially when it comes to obtaining permits and licenses. Although Indonesian government has been trying to improve these situations through simplifying the administrative procedure, this fragmented authority could still be a time-consuming issue especially for foreign investors with limited knowledge of local situations. On a positive side, compared to the case of Japan, there are fewer issues reported by practitioners in Indonesia regarding conflicts with local communities, and fisherman cooperatives and agricultural committee. However, especially for foreign investors it is important to maintain good communication with local communities and other related local stakeholders since they could be bottleneck for obtaining some permits and licenses.

The proposed guideline for analyzing enabling environment for FDI in mini-hydro energy in developing countries is expected to be the basis of future analyses of other developing countries.

6. Policy Recommendations

This chapter provides the key policy recommendations derived from these analyses presented in this thesis and other related preceding studies. These policy recommendations are directed toward policy makers of developing countries with desire to attract FDI in renewable energy sector, and also scholars and evaluators.

For attracting FDI in renewable energy sector, adding to the traditionally argued determinants of FDI including macroeconomic environment, institutional environment, and natural conditions, renewable energy support policies have been shown to have equivalent or stronger influence on location decisions of foreign investors, empirically supported through both quantitative analysis (Chapter 3) and more qualitative analyses involving engagement with experts active in the field (Chapter 4, and 5). However, the analysis based on interviews and questionnaires conducted with experts in the field (Chapter 4) show that some of the traditionally argued determinants such as exchange rate volatility, access to land, and administrative procedure also hold very strong influence as determinants of FDI. There is a broad range of public interventions to reduce investment risks or increase investment returns. And some of the traditionally argued determinants such as exchange rate volatility risk can also be hedged through properly designed renewable energy support policies. The following sections explain the key determinants for attracting FDI in renewable energy, and provide policy recommendations that could be applied to various developing countries aiming to enhance the enabling environment for FDI in renewable energy.

6.1 Exchange Rate Volatility Risk and Renewable Economic Support Policies

Strong volatility of exchange rate indicates currency instability of a country, which is deemed as a very strong determinant affecting FDI in renewable energy in developing countries. Considering the long-term payback period of renewable energy projects, and the role of investment in renewable energy as low-volatility investment in a lot of companies' investment portfolios, a country with high exchange rate risk discourages foreign investors. Exchange rate risk not only affects future return from a project but also raises the cost of finance. From macroeconomic perspective, this implies that host countries need to avoid over-valuation of the exchange rate for maintaining a stable economic environment. However, there are several measures that could be taken by policy makers to reduce exchange rate risk with appropriate design of renewable economic support policies.

Two of the major renewable economic support policies that are employed in a lot of developing countries and deemed as very important support policies by foreign investors are feed-in tariff and auction/competitive bidding. Feed-in tariff and auction system provide payments for electricity from renewable energy at a guaranteed price for a fixed long-time period contract. Some of the ways to reduce the impact of exchange rate risk on FDI projects is to index a portion of the payments made under feed-in tariff or auction system to a foreign currency (e.g. the US dollar). Paying renewable energy projects in tariffs indexed to US dollars or another foreign currency could make the exchange rate risk incurred by the project developer minimal, and debt costs and project costs would fall. Although this means that the government needs to accept some exchange risk exposure, but could potentially benefit from a reduction in the cost of supporting renewable energy through enhanced competition and lowered LCOE of renewable energy projects. In fact in a lot of countries, commodities such as imported oil, coal, and natural gas are priced in US dollars, benefiting from access to capital in dollar terms.

Although the government needs to be willing to accept the full transfer of exchange rate risk from the investors to themselves, the simplest but also more expensive option is to pay the tariff in US dollar. Countries such as Uganda pay the tariff in US dollars (Electricity Regulatory Authority, 2016).

Another option to lower the exchange rate risk is to adjust the tariff rates in line with inflation. This offsets the impacts of depreciation of a currency, and counteracts the interest rate effect on debt repayments. For example, the Philippines adopts this approach, annually adjusting tariffs rates based on the national Consumer Price Index for the entire contractual period (Energy Regulatory Commission, 2010).

6.2 Feed-in Tariff, or Auction/Competitive Bidding?

Feed-in tariff and auction are both employed by a lot of countries, and they are also perceived as two of the most preferred economic support policies by foreign investors based on the analyses presented in this thesis.

Although the effectiveness of feed-in tariff systems is well verified through experiences in various countries, setting the right tariff is a complex exercise especially in countries with limited development of renewable energy. Therefore, for a country that lacks capacity to design feed-in tariff systems, implementing competitive bidding prior to the implementation of a feed-in tariff system is one of the ways to find out appropriate tariffs for renewable energy projects. Competitive bidding systems are preferred by a lot of developing countries partly owing to their controllability by the government. However, competitive bidding also requires careful design in order to make the system cost-effective. First, the process needs to be clear and transparent, and second, the quality of the bid needs to be considered carefully in addition to price. Renewable energy projects developers need deal with complex technologies and contracts, thus developers with more experiences tend to propose reliable prices, with lower risks of delays and failure. South Africa is a good example among developing counties, which sets previous experience of developers as one of the bidding criteria. Although competitive bidding is an effective support policy, from the eyes of foreign investors, recent aggressive competitions among developers of the projects and often time-consuming bidding processes make it questionable if competitive bidding is a long-term support policy that a country can maintain successfully. Including the design of a system, what measures to adopt depends on the conditions of a country, including the macroeconomic situation, overall currency and balance of payment exposure, and the state of the cost of renewable energy projects in the country.

6.3 One-stop Agency for Efficient Administrative Procedure

Renewable energy projects require various permits and licenses for the development and operation of the projects, involving various ministries and stakeholders. Obtaining permits and licenses can be a slow and unclear process for some developing countries, especially for foreign investors considering the information asymmetry in relation to that of domestic companies.

The lengthy approval processes often arises from an over-complex set of administrative responsibilities for different renewable energy sources, at the national level, and also between authorities at several decision-making levels (national, provincial, and local). Resolving the complex and inefficient administrative procedures would promote project implementation and enhance the enabling environment for FDI in renewable energy projects.

In the case of Indonesia, there are generally around 14 permits and licenses required to carry out renewable energy projects, of which 9 need to be obtained at the local level. Different notions among local authorities, and sometimes-unclear decision-making power distribution between different levels of authorities had been slowing down renewable energy development. In order to resolve the complex procedures, a one-stop agency was established by the Indonesian government in BKPM, which is an investment service agency. One-stop agencies are administrative entities that guide investors through all stages of an investment process, including planning, application for approval, approval procedure and project implementation. They contact the relevant authorities, submit the required documents and function as a ‘bridge’ between investors and the administrative system as presented in Figure 6.1. One-stop agencies can simplify the tiring process needed for obtaining the required permits and licenses from different levels of authorities through creating the common understanding between different authorities and making the procedure more transparent.

In order to make the one-stop agency function well, it demands a good awareness of the bureaucratic barriers to investment, and most importantly intense collaboration between authorities at several decision-making levels. Also, a one-stop agency better be approved and accepted at higher administrative levels (the national and provincial levels). Creating a consistent and harmonized understanding at the different levels of government is very important, which provides credibility and coherent signals to potential investors. Having a one-stop agency for renewable energy projects would not only smooth the development renewable energy, but also works as a positive signal for foreign investors.

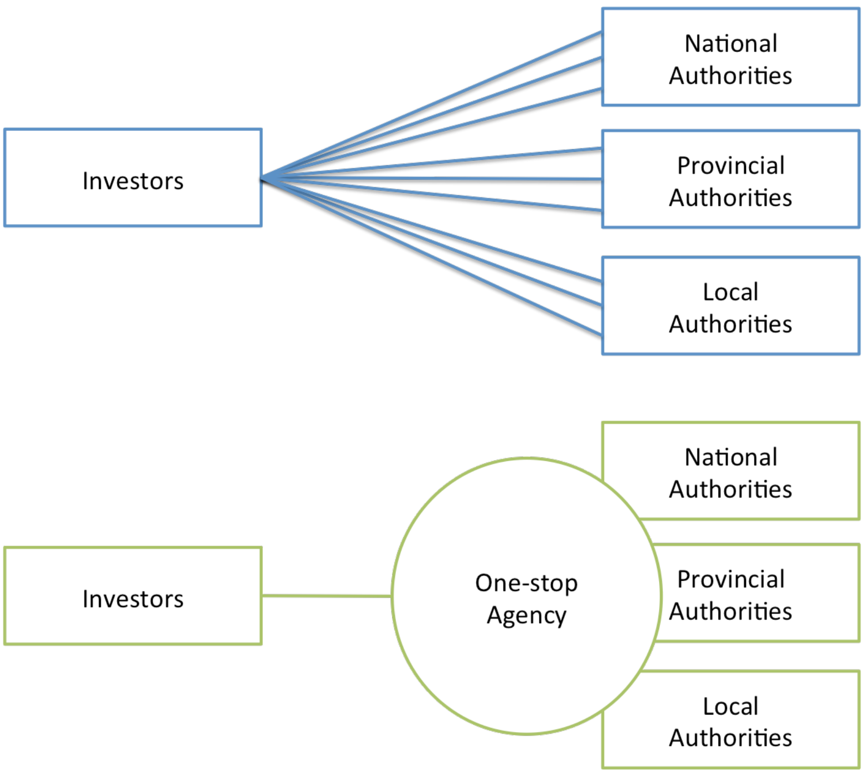


Figure 6.1 The structure of an one-stop agency

6.4 Renewable Energy Resource Mapping and Improving Access to Land

The availability of natural resources and access to land are both very important determinants of FDI in renewable energy in developing countries. Mapping the potential for renewable energy production within a certain region or municipality could greatly enhance attractiveness for potential investors. Resource mapping provides insights about the economic viability of specific production sites and enables estimations for the initial feasibility study.

Another important point is access to land. Access to land is essential for the developers. For some developing countries, project developers need to engage with actors that don't have formal property rights to their land, especially in remote areas. Through conducting resource mapping, coordination between stakeholders for land-use planning for renewable energy development can be improved, and leads to identification of areas that need land-use adjustments to enable renewable energy development.

Detailed mapping of renewable energy potential and improving land access issues require comprehensive local and provincial coordination, and collaboration between different responsible units at local level. Therefore, similar to the concept of one-stop agencies, a cross-departmental committee that coordinates and oversees the process could be an important success factor.

6.5 Access to Grid, and other Regulations

Access to grid is a very strong determinant of FDI in renewable energy in developing countries. Considering that most of the renewable energy FDI projects are conducted with project finance scheme, if there are any risks in grid connection that affects the future revenue of the project, the company would not be able to obtain financing for the project. In a lot of developing countries, even after regulatory liberalization, private project developers, especially foreign investors can encounter difficulty in accessing the grid, sometimes leading to significant delay of the projects. Empirical results suggest that providing guaranteed access to grid leads to increase in investment in electricity sector (Araújo, 2011). Thus guaranteeing open and rapid regulated access to the grid could greatly enhance the enabling environment for FDI in renewable energy in developing countries.

There are also other regulations and incentive tools that impose restrictions on foreign investors for implementing renewable energy projects, which include local content requirements and import tariffs. Strong local content requirements prevent facilitation of renewable energy development since the foreign investors have to depend on the local supply chain's quality and capacity. This not only implies that foreign investors can't benefit from low-cost equipment that are produced outside of the host country, but it also creates less-competitive environment in the host country and affects the government of the host country through increasing the required support to develop renewable energy. Local content requirements can also increase technology risk that affects both the developer and the electricity system with the limited capacity of local supply chain. This can also lower the comparative advantages of foreign investors who have access to low-cost finance, since it may become hard to obtain finance for such projects. Especially in the case of renewable energy projects, the large upfront cost often offers comparative advantages to the foreign investors who have access to lower-cost capital, and this may be one of the important reasons why investment is increasing from developed to developing countries in renewable energy sector. This point is further illustrated in Appendix A, which investigates the effect of differences in interest rate on LCOE of renewable energy projects and traditional diesel energy projects in Indonesia.

Imposing local content requirements would not only decrease the attractiveness of the host country as an investment location, but often tends to slow down the development of the renewable energy sector of the country. Furthermore, these measures might not increase value-added in renewable energy sector considering that a large part of the value created (in USD/MW installed) in renewable energy is generated after the manufacturing phase (EEW & NRDC, 2012).

In some countries, in order to benefit from policies such as FIT, foreign investors need to limit their equity in renewable energy projects to certain thresholds (SEDA, 2012). These investment measures can be subjected to anti-dumping and countervailing duties, and are being challenged under World Trade Organization rules in some countries (Ang, 2015). These trade-related measures could bring more costs than benefits through discouraging FDI in renewable energy sector, limiting the chances to embrace the high innovative potential that FDI can bring to host countries. Considering these negative effects that the trade-related barriers may bring, policy makers of developing countries need to be very careful adopting such measures.

7. Conclusion

The objective of this thesis is to examine location determinants of FDI in renewable energy in developing countries, and to clarify what is the enabling environment to attract FDI in the sector. In order to fulfill the aim of the thesis, this thesis builds on the findings of existing literature and substantiates them by employing holistic analytical approaches, including econometric approaches using SEM analysis, qualitative approaches using AHP analysis, and case studies though social implementation of mini-hydro energy projects and field surveys building up on the social implementation.

7.1 Summary of Contributions to Research and Practice

The first finding of this thesis is that renewable energy support policies have equivalent or stronger effects on location decisions of foreign investors when compared to traditional FDI location determinants such as macroeconomic environment, institutional environment, and natural resources. This has been clarified through using both econometric analysis and analysis involving interactions with experts in the field. The analyses show that sector-specific determinants are very important factors to consider in order to further our understandings on the determinants of FDI in developing countries. Most of the empirical studies on the determinants of FDI have examined the determinants of FDI focusing on overall FDI, with much a smaller number of studies addressing this issue focusing on a specific industry or sector. This study has not only revealed the determinants of FDI in renewable energy in developing countries, which has been attracting a large part of FDI made in developing countries, but also further showed that determinants of FDI could differ among different sectors. Adding to this, this thesis provides supporting evidence to the importance of policy interventions as determinants of FDI, suggested by Dunning and Lundan (2008).

Second, through interactions with experts in the field, and analysis using AHP (Chapter 4), the determinants of FDI in renewable energy in developing countries have been further broken down including specific renewable energy support policies, and the relative significance among the determinants have been clarified. These findings offer criteria for prioritizing policies and actions that can lead to enhancement of a country's enabling environment for FDI in renewable energy. The analysis has shown that determinants such as exchange rate volatility, access to land, resource availability, feed-in tariff system, and guaranteed access to grid hold very strong impact on the location decisions of foreign investors.

Third, through the social implementation of mini-hydro energy projects, and field survey focusing on Indonesia, an assessment guideline of enabling environment for FDI in mini-hydro energy in developing countries is developed. Assessment of Indonesia's enabling environment using the proposed guideline revealed several important points.

Assessment of Indonesia's enabling environment using the proposed guideline revealed several important points to be considered. Although there are a lot of untouched potential sites for the development of mini-hydro energy, it is not easy to find a site with commercially viable conditions. First, the purchase price under the newly revised FIT is relatively low. Next, considering that grid infrastructure is not well developed in regions with high FIT purchase price, there could be extra cost for a project in a region with poor grid infrastructure, or in a remote area far from grid infrastructure. There are also risks stemming from discrepancies and lack of understanding in some government bodies especially when it comes to obtaining permits and licenses. Although the situation has been improving with the introduction of one-stop agency, the fragmented authority could still be a time-consuming issue especially for foreign investors with limited knowledge of local situations. On a positive side, there are not many issues reported by practitioners in Indonesia regarding conflicts with local communities, and fisherman cooperatives and agricultural committee. However, especially for foreign investors it is important to maintain good communication with local communities and other related local stakeholders since they could be bottleneck for obtaining some permits and licenses.

The analysis has provided guideline for analyzing enabling environment for FDI in mini-hydro energy in developing countries that could be the basis of future analyses of other developing countries.

Based on the analyses in the preceding chapters, the key policy recommendations that could be applied to various developing countries aiming to enhance the enabling environment for FDI in renewable energy are provided in Chapter 6.

7.2 Limitations and Directions for Future Research

This thesis is, to my knowledge the first study to empirically investigate the determinants of FDI in renewable energy in developing countries including broad rage of potential determinants revealed through in-depth literature review, interactions with experts, and activities in the field. As with any piece of research, this study is subject to some limitations that provide future scientific avenues. Some of the limitations related to the method are outlined first, followed by more general aspects.

In order to empirically test the effectiveness of renewable support policies on the location decisions of foreign investors, this thesis employed econometric approach using SEM analysis, and also more qualitative approach using AHP analysis. The analyses have effectively shown the impact of renewable support policies such as feed-in tariff, local content requirement, and guaranteed access to grid. This provide strong implication that future analysis of determinants of FDI should focus more at sector and industry level, and include sector-specific factors as potential determinants of FDI to understand the true determinants.

However, the first limitation of this thesis doesn't consider the impact of the differences of tariff rate, which is the limitation of the analysis methods employed. The actual impact of a policy tool like feed-in tariff system depends on the tariff rate, and also the structure of the system. The future analysis could focus on investigating the impact of the economic support policies using the analysis method such as conjoint analysis, which enables to assess how the practitioners respond to the different set of conditions including differences in the tariff rate. The key determinants identified in this thesis could be the basis for formulating the key set of conditions to conduct the conjoint analysis.

Second limitation is that when analyzing the determinants of FDI, it is also important to consider the differences of the investors. In reality the investment decisions about renewable energy are not taken by one type of financial actor alone, but instead there is heterogeneity among investor types. For example, corporate (e.g. electric utilities), financial (e.g. insurance companies, pension funds) and retail investors all invest in renewable energy projects, but their preferences and characteristics could differ. Thus, segmentation of the investors would be the next step to further our understanding of the determinants of FDI in renewable energy in developing countries. While there is a little empirical evidence so far, systematically investigating differences of investors such as required rates of return, preferences for initial down payments, and attitude toward various risks could be one approach.

Another extension of the work presented in this thesis is related to regional focus. This thesis has focused on the location determinants of FDI in developing countries, considering the growing FDI in the countries and the importance of FDI for the host countries. Currently developing countries and developed countries are attracting FDI around the same amount. One could analyze the determinants of FDI in renewable energy in developed countries and see how it differs from that of developing countries.

Finally, the next step of the research is to investigate the impact of FDI in the host countries. This could be conducted through examining the environmental impacts, employments effects, capacity building effects, and costs and development time of FDI projects and compare with that of domestically conducted projects. This will clarify what kind of impact FDI projects in renewable energy could bring in developing countries, and enhance the awareness of policy-makers and practitioners of the importance of creating enabling environment for FDI in renewable energy to accelerate the transition toward sustainable energy system in developing counties.

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Appendix A The Effect of Interest Rates on LCOE of Renewable Energy Projects[4]

In order to investigate the effect of different interest rates on levelized cost of energy (LCOE) of renewable energy projects, the economic viability assessment of the projects is performed by comparing the LCOE of the system with that of the conventional diesel system under different financial scenarios. This study analyzes the economic viability of renewable hybrid mini-grid systems with solar Photo-Voltaic cells, batteries, and diesel generators in a typical un-electrified village in Indonesia employing up-to-date data.

Various sensitivity analyses have been performed, and the study has clarified that even at the most conservative scenario with 100% equity finance, the LCOE of the renewable hybrid mini-grid system is lower than that of the diesel system. The analysis also demonstrates that the profitability of renewable hybrid mini-grid systems are highly affected by financial structure (debt/equity ratios) in comparison with that of diesel mini-grid systems.

A.1 Methods and Data

The project site affects the economic viability of the project by changing the cost of fuel, components, and availability of renewable resources. In this analysis, given its relatively low electrification ratio among islands in Indonesia, a generic village with 1,475 people in 350 households in Nusa Tenggara Timur (NTT), which is located at latitude 10°47.7′ south and longitude 122°51.4′ east, is set as the assumed project site. However, sensitivity analysis is conducted for prices of components and fuel accounting for transportation costs, thus the outcome of the analysis could be applied to other locations with similar renewable resources. The optimal renewable hybrid mini-grid systems are designed utilizing HOMER simulation techniques based on the electricity demand profile, renewable resources and technical details, as well as the costs of components. Due to the lack of the actual ground measured solar irradiance data in the region, daily average solar irradiance data is used, which is obtained from NASA Surface meteorology and Solar Energy database based on the latitude and the longitude of the assumed project site. Since the solar irradiance data is daily average data, the hourly basis effect of clouds and rain are not taken in to account in this study. Assumption of the electricity demand profile shown in the Figure.A.1 is created based on the typical electrical appliances for remote villages in Indonesia with day-to-day random variability of 10% and time-step variability (60 minutes) of 20%, and without any seasonal variability. In this assumed electricity

[4] For more detail presentation of the study, refer to the following paper: Keeley, A. 2017. The Importance of Financial Cost for Renewable Energy Projects - LCOE Analysis of a Case in Indonesia. SSRN Working Paper

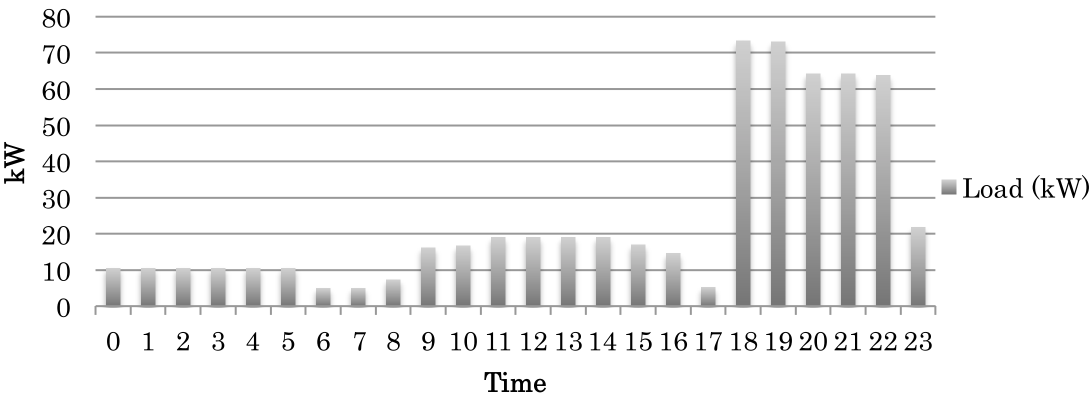

Figure. A.1 Electricity demand profile of the generic village

* Created based on Blum (2012)

demand profile, the total average daily electricity demand at the village is 586.65 kWh, with a peak load of 124.39 kW.

The examined renewable hybrid mini-grid system consists of solar PV, batteries, converters, diesel generators, and grid networks. The latest data on average component prices and their operation and maintenance costs (O&M) for solar PV, batteries, converters, and grid networks in Indonesia were provided by the Ministry of Energy and Mineral Resources of the Republic of Indonesia in June, 2016 (Directorate of Various New Energy and Renewable Energy, 2016).

Table A.1 Summary of cost of components and fuel

*Created based on Directorate of Various New Energy and Renewable Energy (2016)

Components	System Cost	O&M Cost	Replacement Cost
Solar PV	US$2,100/kW to US$3,150/kW	US$19/yr/kW	-
Batteries	US$180/unit to US$270/unit (1 kWh generic Lead Acid Battery)	US$10/yr/unit	US$150/unit to US$225/unit
Converters	US$900/kW to US$1,350/kW	US$7.8/yr/kW	US$800/kW to US$1,200/kW
Diesel Generators	US$650/kW	US$0.05/hr/kW	US$650/kW
Transmission Infrastructure	US$2,000/km	US$160/yr/km	-
Fuel Cost	$0.5007/litter to $1.367/litter	-	-

The given data did not include transportation costs for the components, which could drive up the prices to a great extent when projects are conducted in remote areas, thus sensitivity analysis with multipliers up to 1.5 are taken for the costs of solar PV, batteries, and converters. Multiplier 1.25 would be considered as a reference case for the assumed project site in the analysis, and multiplier 1.5 could be considered as a conservative view. The cost of diesel generators and their average O&M costs are assumed based on the data published by Lazard (2016). Residential fuel price in Indonesia in December 2015 (IEA, 2016) is used as the fuel price in the analysis, and again to take transportation cost into account, as a proxy to reflect the location-dependence differences, multipliers up to 2.73 are considered. The multipliers are calculated based on the analysis of PLN’s official cost of electricity in the entire networks they serve, which provides: low cost (equivalent to the lowest official diesel price), medium (two times higher than the lowest cost) and high (2.73 times higher than the lowest cost). Medium (2) would be considered as a reference case for the assumed project. The costs of components and their replacement costs, O&M costs and fuel cost are summarized in Table A.1.

LCOE of renewable hybrid mini-grid systems and diesel-based mini-grid systems are calculated using:

$$\mathrm{LCOE} = \mathrm{PkWh} = \frac{\sum_{t=1}^{25}(Capital_t + O\&M_t + Fuel_t)^{*}(1+\mathrm{r})^{-t}}{\sum_{t=1}^{25} kWh(1+\mathrm{r})^{-t}} \quad , \qquad \text{(A.1)}$$

where: “PkWh = the constant lifetime remuneration to the supplier for electricity; kWh = the amount of electricity produced in MWh, assumed constant; $(1+\mathrm{r})^{-t}$ = the discount factor for year t (reflecting payments to capital); $Capital_t$ = total capital construction costs in year t; $O\&M_t$ = operation and maintenance costs in year t; $Fuel_t$ = Fuel costs in year t (Hisham, 2016).”

The discount rate used in the analysis is based on weighted average cost of capital (WACC), which is calculated for the following three cases using cost of equity, cost of debt, and corporate tax in Indonesia: debt/equity ratio (D/E) of 4, 1, and 100% equity. WACC is calculated using:

$$\mathrm{WACC} = \frac{E}{V} \times R_e + \frac{D}{V} \times R_d(1 - C_x), \qquad \text{(A.2)}$$

where: R_e = cost of equity; R_d = cost of debt; E = market value of the firm’s equity; D = market value of the firm’s debt; V = E + D; C_x = corporate tax rate.

Cost of equity is calculated using:

$$R_e = R_f + \beta \times R_p, \qquad \text{(A.3)}$$

where: R_f = risk free rate; β = beta (a statistical measure of the volatility); R_p = market risk premium.

The numbers used for the calculation of WACC is summarized in Table A.2.

Table A.2 Summary of inputs for calculation of WACC

*Created based on a: Trading Economics (2016) and b: Fernandez et al (2016)

Risk Free Rate	7.62%[a]
Market Risk Premium	8.0%[b]
Beta	0.84
Cost of Equity	14.34%
Cost of Debt	12.27%
Corporate Tax Rate	25%

A.2 Results

The WACC for the three different D/E ratios under the aforementioned cost of debt, cost of equity, and corporate tax rate in Indonesia are provided in Table A.3.

Table A.3 WACC for three different financial structures

D/E Ratio	WACC
4	10.23%
1	11.77%
100% Equity	14.34%

Table A.4 Components and LCOE of mini-grid systems with WACC of 11.77%.

System	Composition		LCOE
Renewable Hybrid Mini-grid system	Solar PV	60kW	$0.57
	Diesel Generator	140kW	
	1 kwh Lead Acid Battery	200 strings	
	System Converter	30kW	
	Transmission Infrastructure	3.5km	
Diesel Mini-grid system	Diesel Generator	140kW	$0.60
	Diesel Generator	30kW	
	Transmission Infrastructure	3.5km	

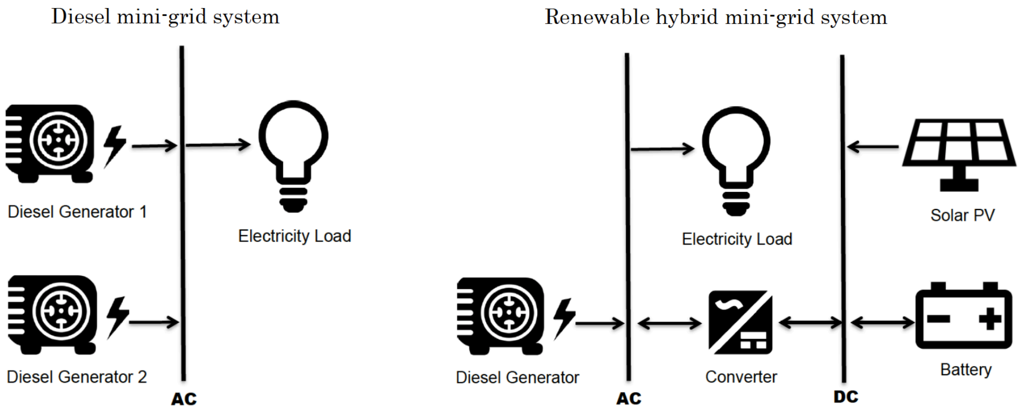

Figure A.2 System diagrams of the optimal mini-grid systems

Based on the assumed electricity demand profile, renewable resources, and technical details, costs of components and discount rates (WACC), the optimal mini-grid systems are designed for a generic village with 1,475 people in 350 households in NTT, Indonesia, using HOMER simulation techniques.

Table A.4 summarizes the components and LCOE of the optimal renewable hybrid mini-grid system and diesel mini-grid system in the reference case with WACC of 11.77%. The result presented in Table A.4 show that LCOE of the renewable hybrid mini-grid system is lower than that of the diesel mini-grid system. In this case, 60kw of Solar PV provides over 40% of the total generation to meet the total electricity demand, which cuts CO_2 emission by approximately 66% over the 25-year lifetime of the system. Figure A.2 shows the system diagrams of both systems. Fig.A.3 shows an example of how the PV, the diesel generator and batteries could interact with each other to serve the village load in one day in June in the reference case. Since the electricity demand is given with day-to-day random variability of 10% and time-step variability (60 minutes) of 20%, the demand varies in different days, so as how the electricity is

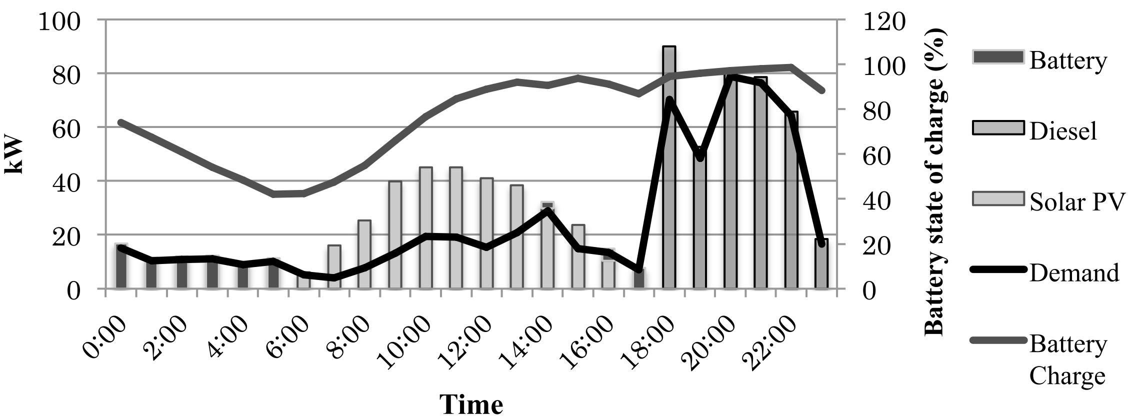

Figure A.3 Demand profile and power output of the hybrid system served.

The result of sensitivity analysis for LCOE of renewable hybrid mini-grid systems and diesel systems with different WACC is presented in Figure. A.4. The LCOE is presented in ranges in Figure A.4: the lower bound is with components prices and fuel prices equivalent to that of mainland Indonesia. The reference case is with components prices and fuel prices of mainland multiplied by 1.25 and 2, respectively. The higher bound is with components prices and fuel prices of mainland multiplied by 1.5 and 2.73, respectively. As shown in Figure A.4, since renewable hybrid mini-grid systems are more capital intensive, their LCOE increases at a higher rate compared to that of diesel mini-grid systems as the discount rate increases. The analysis shows that with high discount rates, LCOE of diesel systems can be lower than that of hybrid systems at the lower bond (the lowest component and fuel prices). However, in the reference cases, high operation cost of diesel mini-grid systems make the LCOE of renewable hybrid mini-grid systems lower than that of diesel systems even under the most conservative case with 100% equity financing (WACC:14.34%).

These results clearly show that when project site is remote enough from the mainland, renewable hybrid mini-grid systems cost less than diesel mini-grid systems for electrification purposes providing 24-hour reliable electricity under the assumptions in this study, and it provides empirical evidence that the economic viability of renewable energy projects are greatly affected by interest rate (WACC) when compared to traditional diesel-based projects. This clearly shows that foreign companies with access to low-cost finance, which is often much higher in developing countries, have comparative advantages and could work as a great financial channel to accelerate the implementation of renewable energy projects.

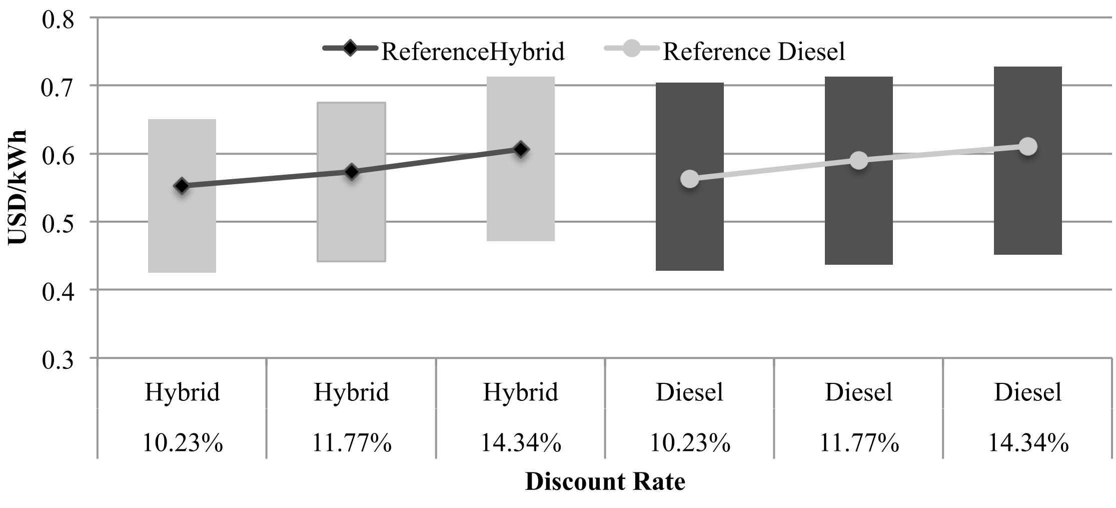

Figure A.4 LCOE of renewable hybrid mini-grid systems and diesel mini-grid systems

Appendix B Expert Interview Material

KYOTO UNIVERSITY

NACC
NAGASAKI UNIVERSITY

Investors' Perspective on Determinants of Foreign Direct Investment in Renewable Energy

-Interview Material-

Interviewee:

Introduction

Thank you for your participation in this interview. We have identified you as one of the major experts in decision mamaking positions in multinational companies working on renewable energy projects overseas.

This study sets out to explore diverse factors that create an attractive environment for foreign direct investment in wind and solar energy projects. At this stage of the research, we have conducted an extensive literature review, and identified 24 factors that are broadly categorized into institutinal environment, macroeconomic environment, natural conditions, and renewable energy policies. In order to validate and narrow down the factors, we kindly ask you to express your perception of the presented factors.

Followings are the two main questions that will be asked during the interview:

- How does each factor influence location decisions of investments?
- Which factors are considered to be less important than other factors?

Confidentiality

Your response will be treated confidentially (name of the interviewee and affiliations are not going to be cited in any publicly available text) and the results are used for academic purposes only.

Contact:

Alexander Ryota KEELEY

*Ph.D. Candidate at Kyoto University, Japan

Email: keeley.ryota.22a@st.kyoto-u.ac.jp

Ken'ichi MATSUMOTO

*Associate Professor at Nagasaki University; Visiting Senior Scientist at JAMSTEC and ESCP Europe (UK)

Email: kenichimatsu@nagasaki-u.ac.jp

Identified Factors:

Category	Factors
Institutional Environment	Political Risk (the probability of a change of government, and the frequency of political assassinations, violent riots and strikes)
	Rule of Law (effective law enforcement)
	Efficient and Transparent Administrative Procedure
	Corruption
Macroeconomic Environment	Access to local finance (availability)
	Exchange rate stability (less volatile exchange rate)
	Labor Cost
	Geographical Proximity (distance between your HQ to the host country)
	Market size
	Tax rate (corporate tax rate)
	Infrastructure (level of development)
Natural Conditions	Natural Resources (Wind potential, Insolation/sunshine duration)
	Risk of disaster
	Access to Land

Identified Factors

Category		Factors
Renewable Energy Policies	Economic Support Policies	Feed-in Tariff
		Renewable Portfolio Standards and Renewable Energy Certificates
		Auction/ Competitive bidding
		Tax-incentives
	Regulatory Support Policies	Priority/Guaranteed Access to Grid
		Technical Standards (aligned with national standards)
		Absence of Local Content Requirement
	Political Support Policies	National Renewable Energy Target
		Well-Structured Renewable Energy Development Plan
		Social Acceptance

Appendix C Questionnaire Form for AHP Analysis

KYOTO UNIVERSITY

Investors' Perspective on Location Determinants of Foreign Direct Investment in Renewable Energy

-Questionnaire-

Introduction

Thank you for your participation in this questionnaire. We have identified you as one of the major experts working on renewable energy projects overseas.

Global greenfield foreign direct investment in renewable energy has reached more than 10% of the total greenfield foreign direct investment worldwide.

This study sets out to explore the relative importance of the factors that create an attractive environment for foreign direct investment in renewable energy projects. At this stage of the research, we have conducted interviews with major companies active in the oversea renewable energy projects, and identified 18 factors that are broadly categorized into Institutional, Macroeconomic, Natural Conditions, and Renewable Energy Policies. In order to analyze the relative importance of the factors, we kindly ask you to express your perception of the presented factors.

Contact:

Alexander Ryota KEELEY

*Ph.D. Candidate at Kyoto University, Japan

Phone: +81 90 7412 2681 Email: keeley.ryota.22a@st.kyoto-

u.ac.jp Ken'ichi MATSUMOTO

*Associate Professor at Nagasaki University; Visiting Senior Scientist at JAMSTEC and ESCP Europe (UK)

Phone: +81 95 819 2735 Email: kenichimatsu@nagasaki-u.ac.jp

*** To return the questionnaire, you have the following options:**

- If you have Adobe Reader installed, you can fill out the answering sections directly in this document, then save the changes and upon completion return it via email to
  keeley.ryota.22a@st.kyoto-u.ac.jp
- You can print out the form, fill out the blanks per hand and then scan and email the document to the above mentioned addresses

Expert Responder Profile

Name:

Company/Organization:

Department/Position:

Country:

Email:

Phone:

---

*__In order to fill in please click just above the line__

Confidentiality

Your response will be treated confidential and the results are used for academic reasons only. Your response will be treated confidentially (name of the interviewee and affiliations are not going to be cited in any publicly available text) and the results are used for academic purposes only.
You may reserve your right to anonymity if you wish to do so.

Instruction

Summary of the introduction:

1. **Please evaluate the relative importance of each factor comparing with another factor using scale 1 to 9**
2. **If you have any comment on the presented factors, please write in the comment section provided next to the brief explanation of each factor**

This questionnaire asks you to evaluate relative importance of categories (Institutional, Macroeconomic, Natural Conditions, and Renewable Energy Policies) and factors that constitute each category on a scale from 1 to 9 (equally important to extremely more important than the others) for each of them.

Below is an example of how to answer the question. The example compares the relative importance of "Institutional" category (Criteria A) to "Macroeconomic" category (Criteria B) when conducting an oversea renewable energy project. If you think Institutional factors (Criteria A) are very strongly more important compared to Macroeconomic factors (Criteria B), then please click "7" on the Criteria A side. Likewise for the second question, if you think "Macroeconomic" factors (Criteria B) are moderately more important compared to "Natural Conditions" factors (Criteria A), please click "3" on the Criteria B side.

*Example Criteria A	9 Extreme	8	7 Very Strong	6	5 Strong	4	3 Moderate	2	1 Equally	2	3 Moderate	4	5 Strong	6	7 Very Strong	8	9 Extreme	Criteria B
Institutional	○	○	◉	○	○	○	○	○	○	○	○	○	○	○	○	○	○	**Macro-economic**
Macro-economic	○	○	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	**Natural Conditions**

In the following pages, first you are asked to compare the broad categories: (***Institutional, Macroeconomic, Natural Conditions, and Renewable Energy Policies***), and next to compare ***sub-categories of Renewable Energy Polices***, and finally ***the factors that constitute the categories***. A brief explanation on each category and factor is provided. There is also comment section next to each brief explanation, in which we would greatly appreciate your thoughts/suggestions/ideas with respect to the factors presented.

1. Evaluation of the Four Broad Categories

Based on the short description of each category with lists of factors in each category provided below, please make a careful evaluation of which category is more important when conducting overseas renewable energy projects (when choosing investment location/country).

Category	Brief Explanation	Comment Section
Institutional	Factors regarding stable government, effective law enforcement, and efficient and transparent administrative procedures.	
Macroeconomic	Factors related to the stability of the exchange rate, labor costs, and the extent of development of local financial market.	
Natural Conditions	Factors regarding the condition of natural resources (wind potential, insolation/sunshine duration), and ease of access to land.	
Renewable Energy Policies	Factors including economic support such as Feed-in Tariff, regulatory support such as guaranteed access to electricity grid, and political support such as having renewable energy targets and development plans.	

Criteria A	9 Extreme	8	7 Very Strong	6	5 Strong	4	3 Moderate	2	1 Equally	2	3 Moderate	4	5 Strong	6	7 Very Strong	8	9 Extreme	Criteria B
Institutional	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Renewable Energy Policies**
Renewable Energy Policies	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Macroeconomic**
Natural Conditions	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Institutional**
Natural Conditions	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Renewable Energy Policies**
Macroeconomic	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Institutional**
Macroeconomic	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Natural Conditions**

2. Evaluation of Institutional Factors

Factor	Brief Explanation	Comment Section
Effective law enforcement	Well-functioning legal system, which makes it possible to sue the government or any other related stakeholders if there are any legal issues.	
Political risk	The probability of a change of government, and the frequency of political assassinations, violent riots and politically motivated strikes	
Efficient and transparent administrative procedures (Administrative procedures)	Ease of creating a company, as well as fficiency and transparency of other administrative procedures to operate a business.	

Criteria A	9 Extreme	8	7 Very Strong	6	5 Strong	4	3 Moderate	2	1 Equally	2	3 Moderate	4	5 Strong	6	7 Very Strong	8	9 Extreme	Criteria B
Political risk	○	○	○	○	○	○	○	○	⦿	○	○	○	○	○	○	○	○	**Administrative procedures**
Effective law enforcement	○	○	○	○	○	○	○	○	⦿	○	○	○	○	○	○	○	○	**Administrative procedures**
Political risk	○	○	○	○	○	○	○	○	⦿	○	○	○	○	○	○	○	○	**Effective law enforcement**

3. Evaluation of Macroeconomic Factors

Factor	Brief Explanation	Comment Section
Exchange rate volatility	Fluctuations of exchange rate	
Access to local finance	The degree of development of local financial market (ease of obtaining funding from a local bank).	
Labor costs	The cost of wages paid to workers (for construction, O&M).	

Criteria A	9 Extreme	8	7 Very Strong	6	5 Strong	4	3 Moderate	2	1 Equally	2	3 Moderate	4	5 Strong	6	7 Very Strong	8	9 Extreme	Criteria B
Exchange rate volatility	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	**Labor costs**
Access to local finance	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	**Exchange rate volatility**
Access to local finance	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	**Labor costs**

4. Evaluation of Natural Conditions Factors

Factor	Brief Explanation	Comment Section
Natural resources	Wind potential, Insolation/Sunshine duration.	
Access to land	Stable and reliable access to land (no land-purchase restrictions for foreign companies).	

Criteria A	9 Extreme	8	7 Very Strong	6	5 Strong	4	3 Moderate	2	1 Equally	2	3 Moderate	4	5 Strong	6	7 Very Strong	8	9 Extreme	Criteria B
Natural resources	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	**Access to land**

5. Evaluation of Renewable Energy Policies – Subcategories

Factor	Brief Explanation	Comment Section
Economic support	Economic support for renewable energy, such as feed-in tariff, renewable energy certificates and renewable portfolio standards, competitive bidding, and tax-incentives.	
Regulatory support	Regulatory support for renewable energy, including guaranteed access to the grid, technical standards, absence of local content requirements.	
Political support	Regulatory support for renewable energy, such as national renewable energy targets, renewable energy development plans, and social acceptance.	

Criteria A	9 Extreme	8	7 Very Strong	6	5 Strong	4	3 Moderate	2	1 Equally	2	3 Moderate	4	5 Strong	6	7 Very Strong	8	9 Extreme	Criteria B
Economic support	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Regulatory support**
Economic support	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Political support**
Regulatory support	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Political support**

6. Evaluation of Renewable Energy Economic Support

Factor	Brief Explanation	Comment Section
Feed-in tariff	A system that offers a guaranteed price for electricity generated by renewable energy with a purchase obligation by the utilities for a fixed long-time period, contracts ranging from 10 to 20 years.	
Renewable energy certificates (REC) and renewable portfolio standards (RPS)	RPS obliges electricity producers and/or distributors to either buy or produce fixed amount of electricity generated with renewable energy. REC can be sold and traded and the owner of the REC can claim to have purchased renewable energy.	
Auction/competitive bidding (Auction)	Competitive bidding is a call for running auctions for predetermined quantity of renewable energy under a long-term power purchase agreements.	
Tax-incentives	Tax incentives can come in the form of capital- or production-based income tax deductions or credits, property tax incentives, sales tax reductions, and VAT reductions.	

Criteria A	9 Extreme	8	7 Very Strong	6	5 Strong	4	3 Moderate	2	1 Equally	2	3 Moderate	4	5 Strong	6	7 Very Strong	8	9 Extreme	Criteria B
Feed-in tariff	○	○	○	○	○	○	○	○	⊙	○	○	○	○	○	○	○	○	**Tax-incentives**
Auction	○	○	○	○	○	○	○	○	⊙	○	○	○	○	○	○	○	○	**REC&RPS**
Tax-incentives	○	○	○	○	○	○	○	○	⊙	○	○	○	○	○	○	○	○	**Auction**
Feed-in tariff	○	○	○	○	○	○	○	○	⊙	○	○	○	○	○	○	○	○	**Auction**
Feed-in tariff	○	○	○	○	○	○	○	○	⊙	○	○	○	○	○	○	○	○	**REC&RPS**
Tax-incentives	○	○	○	○	○	○	○	○	⊙	○	○	○	○	○	○	○	○	**REC&RPS**

7. Evaluation of Renewable Energy Regulatory Support

Factor	Brief Explanation	Comment Section
Priority/guaranteed access to grid (Priority access to grid)	A guarantee that all electricity generated obtains access to the grid, allowing the use of a maximum amount of electricity from renewable energy sources from installations connected to the grid.	
Technical standards	Technical standards set for technical systems that are aligned with international standards.	
Absence of local content requirement (Absence of LCR)	Absence of local content requirements (LCR), which is a system that forces foreign companies to choose the supplier of turbines/panels from the companies in the host country.	

Criteria A	9 Extreme	8	7 Very Strong	6	5 Strong	4	3 Moderate	2	1 Equally	2	3 Moderate	4	5 Strong	6	7 Very Strong	8	9 Extreme	Criteria B
Priority access to grid	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Technical standards**
Absence of LCR	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Technical standards**
Absence of LCR	○	○	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	**Priority Access to Grid**

8. Evaluation of Renewable Energy Political Support

Factor	Brief Explanation	Comment Section
National renewable energy target (Renewable target)	Renewable energy target could be laid out both for long term as well as for short term based on the needs and feasibility in each country	
Well-structured renewable energy development plan (Development plan)	Renewable energy development plan refers to a medium to long-term, stable and consistent strategic framework for promoting installation of renewable energy	
Social acceptance	Social acceptance of citizens of host country toward renewable energy	

Criteria A	9 Extreme	8	7 Very Strong	6	5 Strong	4	3 Moderate	2	1 Equally	2	3 Moderate	4	5 Strong	6	7 Very Strong	8	9 Extreme	Criteria B
Renewable target	○	○	○	○	○	○	○	○	⦿	○	○	○	○	○	○	○	○	**Development plan**
Renewable target	○	○	○	○	○	○	○	○	⦿	○	○	○	○	○	○	○	○	**Social acceptance**
Development plan	○	○	○	○	○	○	○	○	⦿	○	○	○	○	○	○	○	○	**Social acceptance**

Comments/Remarks:

If there are any other factors that you think are important to when choosing locations for conducting renewable energy projects, please write in this section.

(*Click below to write comments):

Would you like to receive the final results of this study?

Yes: ◉

No : ○

And finally, thank you very much for your participation.

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